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A comparative study on colour and surface parameters of current esthetic restorative CAD/CAM materials

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***Abstract*---**With the development of newer technologies, computer aided design and computer aided manufacturing help immensely in designing, planning and creating a dental prosthesis with the precise 3-D printing technology. Recently, patients are at increasing demand

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for everlasting colour stability of restorations in such a way that it improves the aesthetic appearance of teeth. CAD/CAM systems are developed to assemble all ceramic materials which restores the aesthetic zone, attributing to the aesthetics and its clinical long-term survivability.A well-known fact that the type, thickness, composition, curing protocols, and polishing methods of resin composites influences the colour characteristics of the restorations. 99 all-ceramic samples with both glazed and polished CAD/CAM were taken into study. The samples were assessed for the surface roughness (Ra) and colour change after immersion in hot and coffee drink and then were subjected to thermocycling for about 30 days. Total samples of 99 among which 33 samples were manufactured from Vita Enamic, Vitablocs Mark II, and Vita Suprinity. All the disc were milled uniformly to obtain a standard dimension of 10mm ×10 mm±0.2 diameter and the thickness of the block ranges from 2.0±0.2 mm based on the manufacturer's instructions using a CAD/CAM machine (Amann Girrbach, Germany) and then glazed. 33 samples were further subdivided into polished and glazed and were subjected to surface treatments. The sample surfaces were modifed to mimic the clinical adjustment of ceramic restorations and then polished. The mean changes and the Ra SD of the examined All-ceramic restorative materials were ranged between 0.56 and 0.59 μm. There were no significant differences associated between the tested materials and the observed p-value is <0.950. The highest ΔE* and SD were reported to be in the VE group (3.05±0.49), followed by the VM II and VS [(2.85±0.26) and (1.86±0.64)]. Moreover, the ANOVA test for ΔE* revealed a statistically significant difference between ceramic materials with p-values <0.001 (Table – 1). The Bonferroni post hoc test was used to evaluate the multiple comparisons between the three CAD/CAM restorative materials, which showed significant differences in the ΔE values between the tested CAD/CAM restorative materials with a p-value <0.001. But the other parameters showed no significant differences. The mean Ra (surface roughness) is increased for all study groups and also the mean colour changes with the highest differences in VM and those in VS but is within clinically acceptable limits. A greater surface roughness was observed in all the glazed with polished subgroups post-immersion in hot and cold coffee drinks and thermocycling. It was highest for polished VM II group. However, the mean colour changes had higher values were observed for VE group but values are within the range of clinical acceptance. Within glazed immersion groups, no mean colour changes were observed however, surface roughness changes were higher in VE cold coffee samples. Within polished immersion groups, higher Ra changes were revealed in VE and VS cold coffee subgroups. Use single spacing and don't exceed 200 words. Put your abstract here. Use single spacing and don't exceed 200 words. Put your abstract here. Use single spacing and don't exceed 200 words.

***Keywords*---**CAD-CAM, all ceramic, surface roughness, colour stability.

Introduction

Computer-aided design (CAD) and computer-aided manufacturing (CAM) are upcoming digital technologies which helps to design, plan and ultimately create dental prosthetics with a precise 3D printing technology.[1] Nowadays, patients are at increasing demand for everlasting colour stability of restorations in such a way that it improves the aesthetic appearance of teeth. CAD/CAM systems are developed to assemble all ceramic materials which restores the esthetic zone, attributing to the aesthetics and its clinical long-term survivability.[2,3] Hybrid - based ceramic is one among the most popular material to manufacture all-ceramic prostheses with its outstanding higher mechanical properties and better biocompatibility than other ceramic materials used for restoration. [4]When a ray of light passes through a translucent substance like tooth or any esthetic agent, some of the ray is absorbed and the remaining light get scattered. [5]Thus, the colour and the translucency are determined by the amount of its scattering and absorption ability along with the spectra of illumination. [6]

The colour stability of the restoration and the surface roughness (Ra) play a role in the success of the restorations in the esthetic prone zone.[7] Egilmez et al evaluated the CAD/CAM Vita Enamic materials had varied surface roughness values (Ra) and surface irregularities. Various studies concluded that feldspathic porcelain or low fusing porcelain materials exhibited stable surface even after its immersion in different materials like coffee staining and after thermocycling. [8]Al moaleem et al found that the surface roughness (Ra) of CAD/CAM zirconia had greater significant effect than feldspathic ceramic. [9]Even though a better aesthetic ceramic restoration is decided in addition maintaining the colour stability of the protheses is difficult to maintain in the oral environmental condition. Kursoglu et al evaluated the diet, immersion time of the prostheses in the stained environment, and the different porcelain surfaces need to the considered for the amount of prosthetic material discolouration. [10]It's been evaluated that the adequate polishing techniques could create a smoother surface on the ceramics similar to the glazed surfaces. [11] CIE lab colour system is colour research followed globally to interpret the values of colours and their differences in the colour change (ΔE*). Clinically it comprises of three components: L* (lightness, brightness, black/white colour), a* b* denoting the chromatic colour characters. [12]

A well-known fact that the type, thickness, composition, curing protocols, and polishing methods of resin composites influences the colour characteristics of the restorations.[13]On the other hand, colour characteristics of novel resin-based materials such as hybrid ceramics is still not fully understood.[14] The aim of the study to compare the colour parameters (hue angle, chroma) among the selected shades with three hybrid CAD/CAM blocks, to compare the translucency parameters among the materials studied, andto determine and compare the surface polishing effect (glossy nature) (ΔE*SCE-SCI) and surface roughness (Ra) of the novel resin-based materials.

Materials and Methodology

99 all-ceramic samples with both glazed and polished CAD/CAM were taken into study. The samples were assessed for the surface roughness (Ra) and colour change after immersion in hot and coffee drink and then were subjected to thermocycling for about 30 days. Total samples of 99 among which 33 samples were manufactured from Vita Enamic, Vitablocs Mark II, and Vita Suprinity. All the disc were milled uniformly to obtain a standard dimension of 10mm ×10 mm±0.2 diameter and the thickness of the block ranges from 2.0±0.2 mm based on the manufacturer's instructions using a CAD/CAM machine (Amann Girrbach, Germany) and then glazed. 33 samples were further subdivided into polished and glazed and were subjected to surface treatments. The sample surfaces were modifed to mimic the clinical adjustment of ceramic restorations and then polished.

The colour measurements were measured using Easyshade Vita probe spectrophotometer (VITA Easyshade® III, VITA, Germany) with a gray background for all the samples using a single operator. All the samples were measured for the CIE-Lab values to provide the numerical values of the 3D colour measurements. L*, a*, and b* values for all the samples were measured thrice, and the average value was considered as ΔE* using the equation. Mean, Standard Deviation of Ra, and average ΔE* of glazing and polishing for CAD/CAM all-ceramic restorative samples of VE, VM II, VS were recorded before and after immersion in hot and cold coffee drink, and were subjected to thermocycling. Microsoft Excel 13 software was used to input the data and analysed using Statistical Package for Social Science (SPSS) version 23.0 (SPSS Inc., Chicago IL, USA). One-way ANOVA paired Student's t-test, and Bonferroni test were applied to detect any significant difference between the groups. P>0.05 was set at the significant level.

Results

The mean changes and the Ra SD of the examinedAll-ceramic restorative materials were ranged between 0.56 and 0.59 μm. There were no significant differences associated between the tested materials and the observed p-value is <0.950. The highest ΔE* and SD were reported to be in the VE group (3.05±0.49), followed by the VM II and VS [(2.85±0.26) and (1.86±0.64)]. Moreover, the ANOVA test for ΔE* revealed a statistically significant difference between ceramic materials with p-values <0.001 (Table – 1). The Bonferroni post hoc test was usedto evaluate the multiple comparisons between the three CAD/CAM restorative materials, which showed significant differences in the ΔE values between the tested CAD/CAM restorative materials with a p-value <0.001. But the other parameters showed no significant differences.

When comparing the surface roughness, the Ra means was nearly the same for the three tested types of ceramic and their surface treatment type. The Ra range was between 0.53±0.55 μm and 0.37±0.32 μm for the glazed specimens. But it was in the range of 0.77±0.65 μm and 0.68±0.39 μm for polished specimens of the ceramic materials (Table 2). The ΔE* values of glazed and polished VE were the highest ΔE* (3.05±0.62 and 3.24±0.39), whereas the lowest was for glazed and polished VS (1.69±0.63 and 2.23±0.57). Student t-test showed a significant

difference between glazed and polished VM II in the mean Ra with a p-value <0.027. However, the ΔE* values are between the glazed and polished VS with a p-value<0.014. (Table – 2)

Table 1
Mean and standard deviation (SD) of surface roughness (Ra), and mean colour change (ΔE*) values of ceramic materials before and after coffee drink immersion and thermocycling (ANOVA test between and within the groups)

Parameters	Mean ± SD	Type of ceramic	Vita Enamic	Vitablocs Mark II	Vita Suprinity	P - value
S Roughness (Ra1)	1.76 1.57 1.86	Vita Enamic Vitablocs Mark II Vita Suprinity	- 0.426 1.010	0.426 - 0.146	1.000 0.146 -	0.126
S Roughness post (Ra2)	2.36 2.13 2.42	Vita Enamic Vitablocs Mark II Vita Suprinity	0.246 1.026 -	- 0.094 1.000	1.000 0.094 -	0.076
Mean Roughness Changes (Ra)	0.56 0.59 0.57	Vita Enamic Vitablocs Mark II Vita Suprinity	1.000 1.000 -	- 1.000 0.004	1.000 1.000 -	0.950
Mean Colour Changes (ΔE)	3.05 2.85 1.96	Vita Enamic Vitablocs Mark II Vita Suprinity	0.002 0.000 -	- 0.000 -	0.000 0.000 -	0.000

Table 2
Mean and standard deviation (SD) of surface roughness (Ra), and colour change (ΔE*) values of the ceramic materials after staining immersion and thermocycling in relation to surface treatment type (t-test)

Parameters	Surface treatment type (Mean ± SD)		P – value (t- test)
	Glazed	Polished	
Vita Enamic Surface roughness Pre (Ra1) Surface roughness Post (Ra2) Mean roughness changes (Ra) Mean colour change ((ΔE*)	 1.56 (0.38) 2.10 (0.23) 0.55 (0.53) 3.05 (0.62)	 1.99 (0.63) 2.68 (0.24) 0.69 (0.52) 3.24 (0.39)	 0.033 0.000 0.219 0.611

Vitablocs Mark II Surface roughness Pre (Ra1) Surface roughness Post (Ra2) Mean roughness changes (Ra) Mean colour change ((ΔE*)	 1.52 (0.54) 1.90 (0.63) 0.37 (0.32) 2.63 (0.23)	 1.77 (0.38) 2.35 (0.59) 0.77 (0.65) 2.69 (0.32)	 0.815 0.044 0.027 0.593
Vita Suprinity Surface roughness Pre (Ra1) Surface roughness Post (Ra2) Mean roughness changes (Ra) Mean colour change ((ΔE*)	 1.40 (0.46) 2.07 (0.49) 0.48 (0.38) 1.69 (0.63)	 2.37 (0.72) 2.84 (0.74) 0.68 (0.39) 2.23 (0.57)	 0.000 0.001 0.158 0.014

Discussion

Due to the increasing demand with regard to long term survivability and colour stability in anterior esthetic restorations among patients lead to the development of All- ceramic materials to a larger extent. After consumption of hot and cold coffee drinks a few amounts of colour changes was noticed. Different food substances might serve as a factor for the colour changes of the prothesis. Thus, this study were conducted to evaluate the effect of surface roughness (Ra) and colour changes in different CAD/CAM ceramic restorative materials after consumption of the beverages and after thermocycling. A significant difference was noticed in the surface roughness (Ra) within different groups studied.[14,15]

Surface roughness versus mean colour change

The Ra mean values for the tested CAD/CAM restorative ceramic materials were 0.56 µm (VE), 0.59 µm (VM II), and 0.57 µm (VS), higher than the value recorded by another study by Egilmez et al[8] (0.012) for VE. Although the recorded ΔE* values were 1.96 (VS), 2.85 (VM II), and 3.05 (VE) within the clinically acceptable values for the three tested materials, these values are consistent with study experimented by Subaşi et al[16] (slightly above 2) for VS, Sarikaya et al[17] (2.094) for VM II, and Colombo et al[18]<3.3for Zirconia. The Ra (surface roughness) plays a vital role in maintaining the surface values and preventing extrinsic stains of the ceramic restorative materials.[7] Results showed that the surface roughness of the samples before and after thermocycling varied and that thermocycling had an impact on Ra, especially in the polished surfaces. The mean Ra values were 0.55, 0.37, 0.48 and 0.69, 0.77, 0.68 µm for glazed and polished samples of VE, VM II, and VS, respectively.

Surface treatments versus mean δe* measurements

The external intraoral prosthesis can be either glazed or polished surfaces. The glaze surface layer is significant to the colour stability of all-ceramic restorative prostheses whereas the unglazed surfaces after occlusal intraoral adjustments should be avoided, and hence careful occlusal evaluation should be done before cementation of the prosthesis.[19] The highest mean ΔE* was 3.05 for glazed VE and 3.24 for polished VE samples (without any significant difference. A study conducted by *Abuobaid* et al[20] recorded ΔE* 2.54±0.27 for polished VE and 1.17±0.59 for reglazed samples. *Acar* et al[13]concluded that VE glazed specimens were lower ΔE* than polished specimens for all-ceramic materials tested. The threshold values were within the clinical acceptable levels. A notable significant difference was observed between polished and glazed surfaces and the p-value < 0.014 in this study. In addition to this a significant colour change is observed after immersion and thermocycling in hot and cold coffee drinks. But these changes were more observed in the polished porcelain sample than the glazed sample of All-ceramic CAD/CAM restorative materials.

Conclusion

The mean Ra (surface roughness) is increased for all study groups and also the mean colour changes with the highest differences in VM and those in VS but is within clinically acceptable limits. Agreater surface roughness was observed in all the glazed with polished subgroups post-immersion in hot and cold coffee drinks and thermocycling. It was highest for polished VM II group. However, the mean colour changes had higher values were observed for VE group but values are within the range of clinical acceptance.Within glazed immersion groups, no mean colour changes were observed however, surface roughness changes were higher in VE cold coffee samples. Within polished immersion groups, higher Ra changes were revealed in VE and VS cold coffee subgroups.

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