Effects of staining liquids and finishing methods on translucency of a hybrid ceramic material having two different translucency levels

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PURPOSE. Beverages may affect the translucency of esthetic dental restorative materials. The aim of the present study was to investigate the effects of coffee and red wine on the translucency of a PICN material with two translucency levels, and finished with different methods. **MATERIALS AND METHODS.** 2M2 high translucent and translucent VITA Enamic hybrid ceramic blocks were investigated. Rectangular specimens with the dimensions of 12 mm × 14 mm × 2 mm were prepared. The specimens were finished and polished with different methods as suggested by the manufacturer. The translucency parameters of the specimens were evaluated before and after 24 hours, 7 days, and 28 days immersion in distilled water, coffee and red wine. Translucency parameters were measured using a portable spectrophotometer. **RESULTS.** At the end of 28 days, there was no statistically significant difference between the groups of specimens kept in coffee (P>.05). In the red wine groups, there was a statistically significant difference between the control group and all other groups (P<.05) at the end of 28 days. **CONCLUSION.** The translucency of hybrid ceramic for a restoration may not be important regarding the effects of coffee on translucency change because the specimens with different translucencies and finishing methods that were immersed to coffee had similar translucency parameters at the end of 28 days. The translucency of hybrid ceramic may be important in the case of red wine, however, since the results showed that highly translucent specimens exposed to red wine demonstrated better translucency parameters than specimens made from translucent blocks at the end of 28 days. ***[J Adv Prosthodont 2017;9:387-93]***

KEYWORDS: PICN; Hybrid ceramic; Translucency; Specrophotometer

INTRODUCTION

The key to achieving natural-looking dental restorations is mimicking all characteristics of the natural tooth in restorations. For this reason, tooth-colored CAD/CAM dental materials are currently the most popular materials in esthetic dentistry. There are many factors affecting the color match of dental restorations with natural teeth,[1-3] and the optical properties of restoration materials are important factors in the color match.[4-8] CAD/CAM dental materials also provide a satisfying esthetics if their optical properties meet the optical properties of the natural tooth structure.

The interpretation of light reflectivity, scattering, absorption, and transmittance phenomena also affect an observer's shade perception of restorations.[9] Translucency is defined as the ability of a layer of colored substance to allow an underlying background to show through.[10] When light encounters translucent substances such as teeth and aesthetic restorative material, there are four phenomena associated with the interaction of the substance and the light flux: (1) specular transmission of the light flux, (2) specular light reflection at the surface, (3) diffuse light reflection at the surface, and (4) absorption and scattering of the light within the substance.[11,12] Translucency is thus an

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important factor that determines the behaviour of light in an object, which also determines the color perception of dental materials.

For an esthetic restoration, not only are natural-looking finished restorations required for a successful esthetic prognosis, but the translucency and shade of the finished restorations must remain satisfactory after a long time period. Translucency is the diffused passing of light through a material so that persons or objects on the opposite side are not clearly visible. Permitting light and diffusing properties are two important features when the translucency of materials is determined. However, extrinsic factors or drinks such as coffee and red wine have effects on the translucency of tooth-colored dental restorations.[10]

The effects of coffee and red wine as staining materials in the translucency of dental materials are reported in the dental literature.[10] The translucency of dental restorations is also influenced by the type of dental materials.[13-20] Thus, the translucency of ceramics and composites is widely reported in the literature. It has been demonstrated that the translucency parameters of ceramic materials are better than composites.[21,22] Polymer infiltrated ceramic network (PICN) is a new generation dental material that combines the ideal properties of both composites and ceramics. Since PICN materials combine the features of ceramics and composites together, their effect on extrinsic factors may be different from those on ceramics and composites alone. There is little information about the effects of coffee and red wine in the translucency of PICN in the dental literature, and thus the aim of the present study was to investigate the effects of coffee and red wine on the translucency of PICN material, with two different translucencies and finished with different methods.

MATERIALS AND METHODS

2M2 High Translucent (HT) and Translucent (T) VITA Enamic (Vita Zahnfabrik, Cuxhaven, Germany) hybrid ceramic blocks were investigated in this study. For both HT and T groups, 180 rectangular specimens with the dimensions of 12 mm × 14 mm × 2 mm were prepared using a low speed diamond saw (Isomed 1000, Buehler Ltd., Lake Bluff, IL, USA) and water cooling. All of the specimens were ultrasonically cleaned in distilled water, additionally cleaned with isopropanol to remove the grease residue, and dried with compressed air. Both HT and T-group specimens were divided into four groups, and the following different finishing procedures were applied: Control Group - no finishing and polishing performed; Technical Group - Vita Enamic Technical Kit applied; Clinical Group - Vita Enamic Clinical Kit applied; and Glaze Group - Vita Enamic glaze applied. The finishing and polishing of the specimens were performed using the methods described in a previous study.[23] The translucency parameters (TP) of the specimens were evaluated using distilled water, coffee, and red wine. Thus, the subgroups (HT Control, HT Technical, HT Clinical, HT Glaze, T Control, T Technical T Clinical, and T Glaze) were further divided into three subgroups (totally 24 subgroups, n = 15) for distilled water, coffee (Nescafe Classic, Nestle) and red wine (DLC Oküzgözü 2011, Doluca, Istanbul, Turkey). Hybrid ceramic-specimens were then exposed to the solutions in an incubator at 37°C. For the preparation of the coffee solution, 15 g of coffee powder was poured into 500 mL of boiled distilled water. After 10 minutes of stirring, the solution was filtered through filter paper. For each specimen, measurements were repeated three times to determine the translucency parameters before immersion, after 24 hours, 7 days, and 28 days. The solutions were renewed daily to prevent plaque accumulation. TP were obtained with a portable spectrophotometer (VITA Easyshade Advance, VITA Zahnfabrik, Cuxhaven, Germany). Before translucency measurements were taken, the specimens were gently washed with distilled water for 5 minutes and then dried with air. The TP of each specimen was then recorded. The calibration of the device was made before each measurement. All of the measurements were taken in tooth single mode, first on a white background (L^* = 93.5, a^* = 0.2, b^* = -1.5) and then on a black background (L^* = 0, a^* = 0, b^* = 0) under the same lightning conditions (D65).

The black background values were subtracted from the white background and values were recorded as a "translucency parameter" (TP). TP was determined as;

$$TP= [(Lblack - Lwhite)^2 + (ablack - awhite)^2 + (bblack- bwhite)^2]^{1/2}$$

These values were calculated for each of the specimens as 24 hours, 7 days, and 28 day measurements. The differences between the groups were then compared. Statistical difference was evaluated using The Kolmogrov-Smirnov normality distribution with the significance set as $P < .05$. Parametric tests were performed. The differences between the groups were analysed with two-way ANOVA and Tukey HSD. For TP values, repeated measurements and ANOVA analyses were made between TPfirst- TP24h- TP7days- TP28days.

RESULTS

Table 1 shows the TP of the HT and T blocks kept in distilled water. At the end of 28 days, there was no statistically significant difference between the T Groups. Furthermore, no statistically significant difference was found at the end of 28 days between HT Technical, HT Clinical, and HT Glaze groups, but these three groups were statistically different from the Control Group. Table 2 shows the TP of specimens exposed to red wine. There was no statistically significant difference between the HT Technical Kit, HT Clinical Kit, and HT Glaze at the end of 28 days. However, these three groups were statistically different from the HT Control Group. There was no statistically significant difference between the T Control, T Technical, and T Clinical Kit groups. Table 3 shows the TP of the specimens exposed to coffee. The HT Technical Group showed a statistically significant difference from both the HT Control and HT Glaze Groups at the 7 day measurements. For the coffee groups, there was statistically significant difference before the 28 day measurements, but at the 28 day measurement, there was no statistically significant difference among the HT and T Groups. Table 4 shows the time-dependent TP of all the HT and T Groups, finished and polished with different methods.

Table 1. Translucency parameters of the HT and T Groups exposed to distilled water

	TP0-FIRST	TP1-24 HOURS	TP2-7 DAYS	TP3-28 DAYS
HT Groups				
HT Control	13.96 ± 0.95[a]	14.32 ± 0.81[ab]	14.41 ± 0.84[a]	13.83 ± 0.77[a]
HT Technical	13.83 ± 0.76[a]	14.46 ± 0.88[ab]	14.39 ± 0.75[a]	14.14 ± 0.68[ab]
HT Clinical	14.51 ± 1.05[a]	14.93 ± 1.04[b]	15.22 ± 1.03[a]	14.77 ± 1.08[b]
HT Glaze	14.38 ± 0.65[a]	13.63 ± 1.27[a]	14.42 ± 0.95[a]	14.64 ± 0.58[b]
T Groups				
T Control	8.76 ± 0.44[A]	8.46 ± 0.57[A]	8.62 ± 0.57[AB]	8.32 ± 0.41[A]
T Technical	8.23 ± 1.19[AB]	8.56 ± 1.31[A]	8.69 ± 1.34[AB]	8.29 ± 1.07[A]
T Clinical	8.58 ± 0.68[AB]	8.74 ± 0.91[A]	8.95 ± 0.93[B]	8.68 ± 0.93[A]
T Glaze	7.95 ± 0.77[B]	7.55 ± 0.64[B]	7.79 ± 0.93[A]	7.98 ± 0.97[A]

There is no statistical difference between groups with the same letters in each column.

Table 2. Translucency parameters of the HT and T Groups exposed to red wine

	TP0-FIRST	TP1-24 HOURS	TP2-7 DAYS	TP3-28 DAYS
HT Groups				
HT Control	13.50 ± 0.74[a]	13.49 ± 1.01[a]	12.94 ± 0.87[a]	11.83 ± 1.31[a]
HT Technical	13.83 ± 1.18[a]	14.46 ± 1.03[a]	14.39 ± 1.27[bc]	14.14 ± 1.06[b]
HT Clinical	14.03 ± 0.80[a]	14.06 ± 0.71[a]	14.11 ± 0.34[c]	13.82 ± 0.35[b]
HT Glaze	14.51 ± 0.53[b]	13.66 ± 0.52[a]	13.28 ± 0.65[ab]	13.37 ± 0.73[b]
T Groups				
T Control	7.60 ± 1.92[A]	7.19 ± 1.90[A]	6.75 ± 1.68[A]	6.53 ± 1.94[A]
T Technical	7.48 ± 1.84[A]	7.61 ± 2.18[A]	7.18 ± 1.96[AB]	7.02 ± 2.14[A]
T Clinical	8.43 ± 0.50[A]	8.56 ± 0.39[A]	8.41 ± 0.37[B]	7.91 ± 0.46[A]
T Glaze	8.05 ± 0.88[A]	8.01 ± 0.92[A]	7.99 ± 0.99[AB]	7.04 ± 1.35[A]

There is no statistical difference between groups with the same letters in each column.

Table 3. Translucency parameters of the HT and T Groups exposed to coffee

	TP0-FIRST	TP1-24 HOURS	TP2-7 DAYS	TP3-28 DAYS
HT Groups				
HT Control	13.72 ± 0.82[a]	14.17 ± 0.75[a]	13.51 ± 0.91[a]	13.36 ± 0.60[a]
HT Technical	14.92 ± 0.64[b]	14.91 ± 0.61[b]	14.61 ± 0.52[b]	14.15 ± 0.55[a]
HT Clinical	14.35 ± 0.63[ab]	14.29 ± 0.76[ab]	13.95 ± 1.15[ab]	13.71 ± 0.89[a]
HT Glaze	14.01 ± 0.57[a]	13.68 ± 0.43[a]	13.80 ± 0.42[a]	13.58 ± 1.37[a]
T Groups				
T Control	7.62 ± 2.03[A]	7.66 ± 2.02[A]	7.09 ± 2.30[A]	7.02 ± 2.13[A]
T Technical	10.86 ± 4.22[B]	9.31 ± 2.58[B]	8.66 ± 2.49[A]	8.80 ± 2.85[A]
T Clinical	8.13 ± 0.33[A]	8.33 ± 0.40[AB]	8.31 ± 0.99[A]	7.98 ± 0.37[A]
T Glaze	8.12 ± 0.40[A]	7.46 ± 0.45[A]	7.06 ± 0.44[A]	7.95 ± 1.47[A]

There is no statistical difference between groups with the same letters in each column.

Table 4. Time-dependent translucency parameters of the HT and T Groups

Group	Measure	Levels	Type III Sum of Squares	df	Mean Square	F	Sig.
HT Control	Distilled water	TP0 vs. TP1	1.901	1	1.901	4.006	.065
		TP1 vs. TP2	.113	1	.113	3.125	.099
		TP2 vs. TP3	4.942	1	4.942	67.518	.000
	Redwine	TP0 vs. TP1	.005	1	.005	.004	.953
		TP1 vs. TP2	4.439	1	4.439	4.143	.061
		TP2 vs. TP3	18.459	1	18.459	59.302	.000
	Coffee	TP0 vs. TP1	3.029	1	3.029	19.670	.001
		TP1 vs. TP2	6.429	1	6.429	24.609	.000
		TP2 vs. TP3	.378	1	.378	.968	.342
T Control	Distilled water	TP0 vs. TP1	1.368	1	1.368	20.665	.000
		TP1 vs. TP2	.371	1	.371	6.484	.023
		TP2 vs. TP3	1.332	1	1.332	16.668	.001
	Redwine	TP0 vs. TP1	2.554	1	2.554	3.978	.066
		TP1 vs. TP2	2.904	1	2.904	28.008	.000
		TP2 vs. TP3	.726	1	.726	2.522	.135
	Coffee	TP0 vs. TP1	.020	1	.020	.054	.819
		TP1 vs. TP2	4.931	1	4.931	10.407	.006
		TP2 vs. TP3	.075	1	.075	.145	.709
HT Technical	Distilled water	TP0 vs. TP1	5.891	1	5.891	30.798	.000
		TP1 vs. TP2	.064	1	.064	.175	.682
		TP2 vs. TP3	.988	1	.988	15.888	.001
	Redwine	TP0 vs. TP1	.691	1	.691	5.593	.033
		TP1 vs. TP2	.019	1	.019	.067	.799
		TP2 vs. TP3	7.505	1	7.505	29.025	.000
	Coffee	TP0 vs. TP1	.000	1	.000	.001	.982
		TP1 vs. TP2	1.374	1	1.374	5.970	.028
T Technical	Distilled water	TP0 vs. TP1	1.720	1	1.720	44.425	.000
		TP1 vs. TP2	.241	1	.241	3.641	.077
		TP2 vs. TP3	64.025	1	64.025	4.558	.051
	Redwine	TP0 vs. TP1	.267	1	.267	.421	.527
		TP1 vs. TP2	2.765	1	2.765	7.731	.015
		TP2 vs. TP3	.390	1	.390	.902	.358
	Coffee	TP0 vs. TP1	36.255	1	36.255	3.313	.090
		TP1 vs. TP2	6.260	1	6.260	26.712	.000
		TP2 vs. TP3	.308	1	.308	.582	.458
HT Clinical	Distilled water	TP0 vs. TP1	2.731	1	2.731	32.828	.000
		TP1 vs. TP2	1.238	1	1.238	22.608	.000
		TP2 vs. TP3	3.065	1	3.065	73.840	.000
	Redwine	TP0 vs. TP1	.008	1	.008	.028	.870
		TP1 vs. TP2	.036	1	.036	.165	.691
		TP2 vs. TP3	1.193	1	1.193	12.110	.004
	Coffee	TP0 vs. TP1	.058	1	.058	.305	.590
		TP1 vs. TP2	1.734	1	1.734	6.287	.025

Table 4. (Continued) Time-dependent translucency parameters of the HT and T Groups

Group	Measure	Levels	Type III Sum of Squares	df	Mean Square	F	Sig.
T Clinical	Distilled water	TP0 vs. TP1	.394	1	.394	2.888	.111
		TP1 vs. TP2	.628	1	.628	4.328	.056
		TP2 vs. TP3	1.056	1	1.056	20.936	.000
	Redwine	TP0 vs. TP1	341.771	1	341.771	.968	.342
		TP1 vs. TP2	.341	1	.341	6.094	.027
		TP2 vs. TP3	3.680	1	3.680	56.922	.000
	Coffee	TP0 vs. TP1	.572	1	.572	5.432	.035
		TP1 vs. TP2	.012	1	.012	.013	.910
HT Glaze	Distilled water	TP0 vs. TP1	8.483	1	8.483	7.733	.015
		TP1 vs. TP2	9.425	1	9.425	7.727	.015
		TP2 vs. TP3	.696	1	.696	1.143	.303
	Redwine	TP0 vs. TP1	10.787	1	10.787	24.501	.000
		TP1 vs. TP2	2.121	1	2.121	3.782	.072
		TP2 vs. TP3	.123	1	.123	.243	.630
	Coffee	TP0 vs. TP1	1.607	1	1.607	2.286	.153
		TP1 vs. TP2	.184	1	.184	.853	.371
		TP2 vs. TP3	.709	1	.709	.300	.593
T Glaze	Distilled water	TP0 vs. TP1	2.400	1	2.400	2.040	.175
		TP1 vs. TP2	.869	1	.869	2.430	.141
		TP2 vs. TP3	.538	1	.538	5.276	.038
	Redwine	TP0 vs. TP1	.023	1	.023	.083	.778
		TP1 vs. TP2	.008	1	.008	.006	.942
		TP2 vs. TP3	85.347	1	85.347	7.290	.017
	Coffee	TP0 vs. TP1	6.494	1	6.494	59.100	.000
		TP1 vs. TP2	2.400	1	2.400	16.612	.001

Level 1: TP0 (first). Level 2: TP1 (24 hour). Level 3: TP2 (7 days). Level 4: TP3 (28 days)
(repetaed mesurements ANOVA)

DISCUSSION

Red wine and coffee consumption are daily routines for most people in our era. There have been a number of dental studies aiming to determine the effects of these drinks on dental restorative materials.[24,25] It has been shown that the dental materials most resistant to extrinsic factors are dental ceramics, and the least resistant are composites.[25,26] There have also been studies in the dental literature evaluating the effects of different drinks on the translucency of ceramics and composites; however, there is limited knowledge about the effects of coffee and wine on the optical properties of hybrid ceramics, with only discoloration having been investigated.[27]

The translucency of the dental materials affects an observer's perception of the color of dental restorations. Most of the translucency and staining studies reported in the literature have evaluated ideally polished dental materials, but non-polished specimens and specimens finished with different methods were also evaluated in this study. In the present study, the specimens were prepared using a slow speed diamond saw and water cooling since the preparation of the specimens with CAD/CAM caused too much block materials wasted. According to the results, the period of exposure to coffee or red wine combined with different finishing methods influenced the translucency of the hybrid ceramic material evaluated in the present study. The results of the study also showed that the specimens finished with different methods and immersed in red wine all showed higher translucency parameters than the control group; however, there was only a significant difference between the 7 day HT and T Groups and the 28 day HT Group. In the red wine groups there was no statistically significant difference between the HT Control, HT Technical Kit, and HT Glaze Groups and these three groups were all statistically significant different from the control group at the 28 day measurements. It was observed that there was no statistically significant difference between the T Groups kept in red wine at 28 days. In the coffee group, the translucency parameters of the HT and T Groups finished with the Technical Kit showed the highest TP; however, TP values only reached statistically significant differences between the 7 day HT Groups. A previous study also showed that the smoothest specimen surface was obtained by finishing and polishing the hybrid ceramic with Technical Kit.[22] This implies that finishing methods and the surface features of the material may be important for the translucency of the material affected by coffee and wine. The results suggest that the translucency of the HT hybrid blocks was affected more than that of the T hybrid blocks after exposure to coffee.

The color perception of a dental restoration by an observer is a complex process influenced by the illuminant and material characteristics of the restorations. The constituents of dental materials such as composite resin or ceramic within the material will absorb various wavelengths of light, allowing other wavelengths to scatter from the restoration.[28] The basis of the dental material used for restorations is therefore important since the light transmission and reflection of every material are different from those of others. In the present study, both high translucent and translucent Vita Enamic blocks were evaluated because the illuminant characteristics of material translucency may also affect the translucency of materials after exposure to coffee and wine.

Knowledge of the response of hybrid ceramics with different translucencies to coffee and wine consumption may help clinicians when choosing the translucency of dental materials for restorations. In the present study, periods of 7 and 28 days were chosen due to the effects of coffee and wine on translucency. It has been reported in the dental literature that 24 hours exposure to drinks *in vitro* corresponds to 1 month *in vivo*.[29] In the present study, specimens were kept in coffee and wine for 24 hours, 7 days, and 28 days, which correspond to 1 month, 7 months, and 28 months *in vivo*, respectively. According to the results of the present study, the translucency level of the chosen hybrid block for the restoration may not be important regarding the effects of coffee on the translucency change for a heavy coffee consumer because specimens with different translucencies and finishing methods exposed to coffee had similar TP at the end of 28 days. For a wine consumer, however, the translucency of the hybrid ceramic may be important since the results of the present study showed that HT restorations exposed to wine might demonstrate better TP then restorations made from T blocks after of 1 month. Although the values did not reach statistically significant levels, finishing the restorations with a Technical Kit may also result in better TP when the material is exposed to coffee and wine. Since the present study only evaluated the effects of coffee and wine on the translucency of hybrid blocks *in vitro*, it is necessary to investigate the coffee and wine exposure of the same materials clinically, or *in vivo*.

CONCLUSION

According to the results of the present study, the translucency of the chosen hybrid block for a restoration may not be important regarding the effects of coffee on translucency change because specimens with different translucencies and finishing methods exposed to coffee had similar translucency parameters at the end of 28 days. However, for a red wine consumer, the translucency of the hybrid ceramic may be important since the results of the present study showed that highly translucent specimens exposed to red wine demonstrated better translucency parameters than the specimens made from translucent blocks at the end of 28 days.

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