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Does increasing the polymerization time have an effect on the coloring of composite resin restorations? / 60 Daily In-Vitro Work

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Abstract

Objective: The aim of this study was to investigate the effect of increasing the polymerization time in composite resin materials on the coloration of composite resin restorations.

Materials and Methods: In this study,40 pieces of 13 mm diameter and 1.5 mm thick composite blocks were used.Samples were subjected to 2 different polymerization times for 20 sec and 40 sec (n=20).Five different solutions (tea, coffee, cola, red wine and distilled water) were used for the staining procedure. Samples were examined by using spectrophotometer according to the time they were kept in solutions.Both polymerization time and solution differences were analyzed and the measurements were analyzed.The color values of each sample kept in solutions for 60 days were measured again on the 1st, 2nd, 7th, 21st, 30th and 60th days and the color change values ($\Delta E00$) were calculated.Statistical analyzes were performed by comparing the ANOVA in multiple groups with the Bonferonni test in paired comparisons, when the mean values of the data provided normal distribution.For nonparametric conditions Kruskall Wallis and Mann Whitney-U and before and after Wilcoxon sign tests were used.

Results: The differences of the solutions for the same days of polymerization were examined and the only difference was obtained on the 7th day of the samples which were kept in the instant and the mean staining values of the samples which were polymerized for 40 seconds were statistically lower than the average value of the polymerized samples for 20 seconds ($p=0.035$).In all other cases, the coloration values of the polymerized samples for a period of 40 seconds were mostly less than the average but statistically significant difference could not be obtained ($p>0.05$).

Conclusion: It was found that increasing the polymerization time of composite resin materials had no effect on coloration as long as it was made in accordance with the rules.

Introduction

Today, many scientific and artistic principles benefit in creating a beautiful smile. In this context, it is important to evaluate the face, lip, gingival tissues and teeth [1]. Among these factors, the color of the teeth is important for a nice smile [2]. Technological advances have been made in order to produce patients' demand for aesthetics and consequently to produce materials with natural tooth-like optical properties [3]. Composite resins produced in this context; adequate durability, the ability to connect to the dental tissues and the relative costs as well as aesthetic features come to the fore [4].

It is very important that composite materials mimic the appearance of natural teeth in terms of color harmony and stability of the tooth. However, composite resin materials have a tendency to change color in the oral environment over time [5]. As a result of coloration in the restorations, patients are uncomfortable with their existing restorations.

One of the most important reasons for the restoration of aesthetic restorations is the coloration of composite resin restoration [6]. It is very important that aesthetic restorative materials maintain their long-term stable structures in the oral environment [7].

The color stability of the restoration is critically important for aesthetic success. The aesthetic long-term success of composite restorations depends on the limitations of the mechanical and physical properties of the composite material used and the external factors that the patient consumes as a habit.

Despite the developments in chemical structures and filler types, composite resins may show color changes after polymerization [8]. Effective polymerization of composite resins is of great importance in the clinical success of composite resin restorations. It is stated that the polymerization affects the abrasion resistance, surface hardness, biocompatibility, residual monomer content and water absorption of composite resins [9,10].

The patient's consumption of cigarettes, tea, coffee, cola, such as carbonated beverages and even water or fluoride in the daily habits of external factors such as composite resin restorations can cause coloration. Briefly, the material content and surface properties of composite resin restorations are effective in coloring the drinks and cigarettes which are consumed as a result of the patient's habits [11].

However, regeneration of the restoration is not a very preferable method, in addition to causing more material loss in tooth tissue and time loss. These effects can be prevented and the lifetime of restorations can be prolonged by knowing the possible effects of physical and chemical factors on composite resin materials [12].

External coloration

Depending on the individual's habits, the colorations caused by the plaque and color pigments accumulated over time in the surface of the composite resin restorations are called external coloring [13-15]. External coloration, contamination of the resin with blood or saliva, inadequate polymerization, poor oral hygiene, smoking and food consumed by the person depending on the habits of the coloring material as a result of frequent contact with the composite surface absorption and accumulation on the surface takes place [16].

Internal coloration

It is a physico-chemical reaction due to the color of the composite resin due to its structure. When light-curing composite resins use tertiary aromatic amine as initiator, coloration results from the conversion of hue value from white to yellow. The matrix content of the resin intrinsic coloration, filler particle size and the ratio of the light-sensitive initiator type, is affected by many factors such as binding agents, color [17-19].

Due to the lower viscosity of the composite resins found in UDMA and the less water absorption, the coloration in these composites is smaller [17-19].

With the use of the CIE L * a * b color system in digital color measurements, the currently preferred system is CIEDE 2000. According to the CIE L * a * b system, each color is expressed in terms of three components called L, a and b. L is the vertical axis of the object white (+), black (-) between the coordinates of the brightness or openness, a horizontal axis of the object red (+), green (-) between the chroma coordinates, b horizontal axis of the object yellow (+), blue (-) between the shows chroma coordinates. The intersection of these three coordinates gives the value of that color. While the color change caused by the difference in brightness is difficult for the eye to perceive, it detects the color change caused by the difference in tone more easily. Therefore, in 2000, international color scientists, such as the CIE L * a * b system, rather than equalizing all variables equal to the perception of the factor affecting the eye more predominantly by determining the factor to be more appropriate and accurate acceptability and perceptibility of CIEDE 2000 formula was developed [20].

Materials and Methods

In this study, the effect of different polymerization times on coloration was evaluated by keeping the composite discs prepared with one composite material in different colorant solutions.

In this study, 1 restorative material was used Filtek ™ Z550 Nano Hybrid Universal. The filler was selected in A1 color. The restorative materials were colored with 5 different solutions such as water, tea, instant coffee, cola and red wine. All materials and manufacturers used for this study are given in Figure 1. The devices used are shown in Figure 2.

Materiel	Product	Manufacturer
Composite Resin	Filtek™ Z550 Nano Hybrit Üniversal (A1 Color)	3M ESPE, St Paul MN, ABD
Polishing Disc	Optidisc Polishing Disc	Sds Kerr Danbury, CT, USA.
Colorant Solution	Yellow Label Black Tea	Lipton, Türkiye
Colorant Solution	Nescafe 3 in 1	Bursa, Türkiye
Colorant Solution	Coke	The Coca-Cola Company, Türkiye
Colorant Solution	Red Wine	Dikmen, Kavaklıdere, Ankara, Türkiye

Figure 1: Table of materials and manufacturers used in the study

Device	Brand and Model	Manufacturer
Light device	3M Espe Elipar S10	3M ESPE, St Paul MN, ABD
spectrophotometer	Lovibond RT Series	The Tintometer® Group, Lovibond House, UK

Figure 2: Table of devices and manufacturers used in the study

Preparation of Samples

In our study, a polytetrafluoroethylene mold having a diameter of 13 mm and a thickness of 1.5 mm was used. A total of 40 samples were prepared. Filtek ™ Z550 Nano Hybrid Universal was used as the composite material. The samples were applied to the disc shaped voids in a single layer and the transparent tape and the cement glass were placed. By applying light pressure, the excess material was overflow and a smooth surface was obtained. Gently increase the composite of the mouth with a spatula and then light with a light intensity of 1200 mW / cm2 (3M Espe Elipar S10, Dental Products, St. Paul, MN, USA) 20 sec (20 samples) and 40 sec (20 samples)) polymerized in accordance with the manufacturer's instructions. After the polymerization was completed, both surfaces of each sample were polished by a single physician with low pressure, light pressure and clinical contraindication and micromotor for 60 sec with polishing discs (Optidisc Polishing Disc Set, Sds Kerr Danbury, CT, USA.) .

To investigate the effect of increasing the polymerization time on coloration, the samples were divided into 2 groups (n = 20).

Group 1: Group polymerized for 20 seconds (control group)

Group 2: polymerized group for 40 sec

After the samples were divided into groups, the initial color measurements were made in the distilled water at 37 ° C for 24 hours. Measurements were made with Lovibond brand spectrophotometer. After initial measurements were made, samples were placed in coloring solutions. As a coloring solution; distilled water, tea (yellow label tea, Lipton, Turkey - prefabricated a tea bag, was allowed to stand 5 min in 150 ml of boiling water and wait 5 min cool down.) instant coffee (Nescafe 3 in 1, Istanbul, Turkey - 3 g of a brown powder, 150 ml of boiling water according to the recommendation of the manufacturer and waited for 5 minutes to cool down.), cola (the Coca-Cola Company, Turkey) and red wine (Dikmen, Kavaklıdere, Ankara, Turkey) 5 different coloring solution was used to be. In the restorative material, distilled water was used to examine intrinsic color changes and as a control.

All samples were incubated in solutions for 24 hours for 60 days and the solutions were changed regularly. The color measurements of all samples were measured on the 1st day, 2nd day, 7th day, 21st day, 30th day and 60th day with both measurements of the samples by the measuring device 3 times and the measurements were averaged. Before each measurement, the samples were washed under running water for 10 sec and dried slightly with paper towels.

Color Assessment

The spectrophotometer (Lovibond, The Tintometer® Group, Lovibond House, UK) was used for color measurements. Before each measurement, the instrument has been calibrated in accordance with the operating instructions and the measurements are made on a standard white surface which is constant in the device itself. The mean L, a, b values were obtained by measuring 3 times from each sample. The ΔE values between the composite samples were calculated using the CIEDE 2000 formula.

Statistical analysis

For statistical analysis, mean, standard deviation and median values were given before and after each sample group. The mean values obtained were compared with ANOVA in multiple groups, and Bonferonni test in paired comparisons for cases where the data provided normal distribution. For nonparametric conditions Kruskall Wallis and Mann Whitney-U and before and after Wilcoxon sign tests were used. The analyzes were interpreted at 95% confidence level. Graphs are plotted with MS Excel 2017. Analysis was made in SPSS 23.0 package program.

Results

For various solutions of the study, color measurements were obtained on the 1st, 2nd, 7th, 21st, 30th and 60th days. In these measurements, a group was polymerized for 20 seconds while the other group was polymerized for 40 seconds.

Measurements and averages were obtained as in Table 1 and Graph 3. In this study, the differences between the days, the changes in the same day results of each solution, the differences between the polymerization conditions for the specific day of each solution and the differences in the polymerization status of the solution in all solutions in terms of day by day were investigated. The colorization according to all solution materials is different regardless of the polymerization time in each day measurement ($p < 0.001$). There is no statistically significant difference in water and cola changes. But in the following days, when water and cola were moving together (there was no difference between the averages), the tea and instant coffee had the same average coloration, and the wine on average had a higher average than all.

When the coloration amounts were examined on average, from the first day of the day, from the 7th day to the tea, tea was colored from the 21st day (> 3,1) and cola and water were not observed. This is the same for both 20 sec and 40 sec polymerization cases.

When the average difference for days for 20 sec and 40 sec polymerization measurements was examined, no coloration was seen in water and arm in days ($p > 0.05$), however, in all other solutions, coloration occurred over time.

Polim. 20	Day_1		Day_2		Day_7		Day_21		Day_30		Day_60			
	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Test	p
Water	0,48	0,28	0,58	0,33	0,46	0,24	0,48	0,36	0,74	0,32	0,87	0,38	0,806	0,241
Tea	1,16	0,26	2,20	0,40	2,73	0,87	4,22	0,84	5,50	1,05	7,20	1,33	29,409	0,020
Nescafe	2,34	0,99	2,78	1,16	4,62	0,80	4,81	0,85	5,22	0,87	6,23	1,16	34,350	0,016
Coke	1,53	1,45	1,50	1,29	1,51	1,21	1,73	1,38	2,01	1,47	1,85	1,28	11,766	0,069
Wine	6,95	1,65	7,92	2,71	11,35	3,79	14,50	4,26	15,58	4,23	19,50	4,90	25,975	0,023
Test-p	44,80	<0,001	31,01	<0,001	43,10	<0,001	56,32	<0,001	61,71	<0,001	76,39	<0,001		
Polim. 40	Day_1		Day_2		Day_7		Day_21		Day_30		Day_60			
	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Mean	St. D	Test	p
Water	0,48	0,39	0,61	0,40	0,72	0,36	1,02	0,47	1,05	0,55	1,13	0,54	0,850	0,172
Tea	1,66	1,02	2,41	1,10	2,87	0,87	3,79	1,10	5,32	1,03	6,53	1,21	76,927	0,005
Nescafe	1,96	1,29	2,25	1,08	3,74	1,25	3,87	1,21	4,25	1,15	5,40	2,07	207,700	0,001
Coke	1,51	0,90	1,60	1,06	1,14	0,63	1,26	0,55	1,50	1,05	1,61	0,74	0,858	0,759
Wine	5,80	2,04	7,64	2,07	9,15	3,36	11,83	3,80	13,60	3,50	16,14	5,15	57,177	0,008
Test-p	21,29	<0,001	37,97	<0,001	32,34	<0,001	43,76	<0,001	63,80	<0,001	44,16	<0,001		

Table 1: Colorization table of samples polymerized for 20 sec and 40 sec

The most important examination in this process is to examine the differences of the solutions according to the polymerization times for the same days. Each p value obtained is given in Table 5. The only difference was obtained on the 7th day of the specimen and the mean staining values of the samples which were subjected to 40 sec polymerization were statistically lower than the mean value of the polymerization samples applied for 20 seconds (p = 0.035). In all other cases, the results of 40 seconds of polymerization were generally less than average, but statistically significant differences were not obtained (p> 0.05).

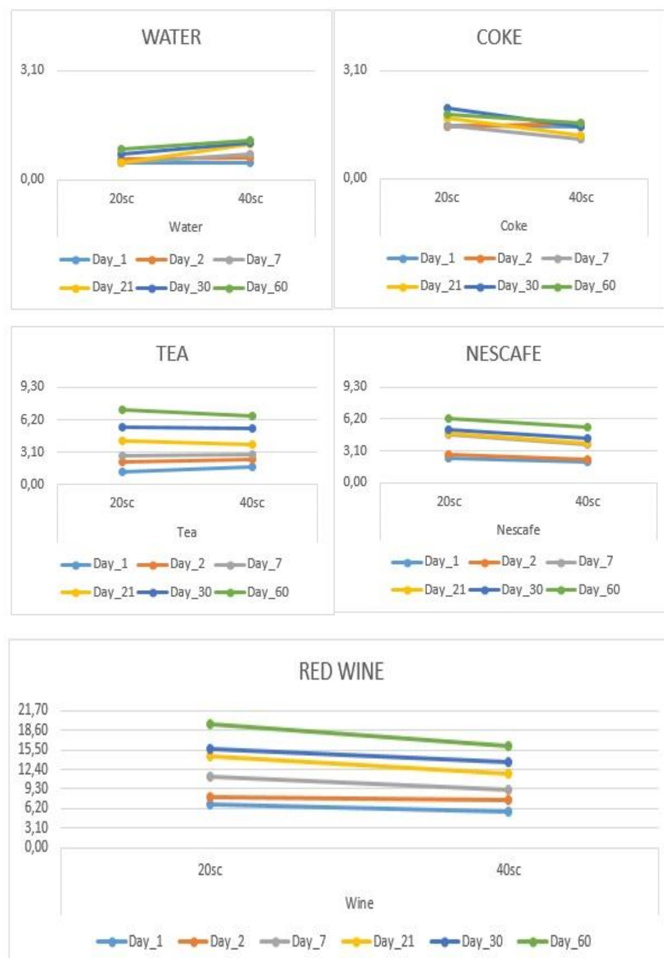
	Day_1	Day_2	Day_7	Day_21	Day_30	Day_60
	p1	p2	p7	p21	p30	p60
Water	0,600	0,916	0,081	0,021	0,294	0,462
Tea	0,248	0,270	0,529	0,462	0,753	0,248
Nescafe	0,401	0,294	0,035	0,115	0,074	0,248
Coke	0,600	0,753	0,753	0,833	0,713	0,916
Wine	0,293	0,916	0,141	0,345	0,401	0,141

Table 2: Table of differences of the polymerized samples for 20 sec and 40 sec.

In addition, when the solutions used in the samples are examined, only the polymerization time is required; mean and standard deviation except for the deviations of the median values are taken to be too large, and the results were not statistically different between 40 sec and 20 sec (p> 0.05). Information about the results can be followed in graphs, water and cola can not pass the coloration status in any day followed, tea 21, 30, 60. and 7th, 21st, 30th and 60th days of the prose both 20 seconds and 40 seconds The colorization values in the polymerization for a period of time have an average value of more than 3.1. The coloration of the wine is always higher than 3.1 in every polymerization on all days.

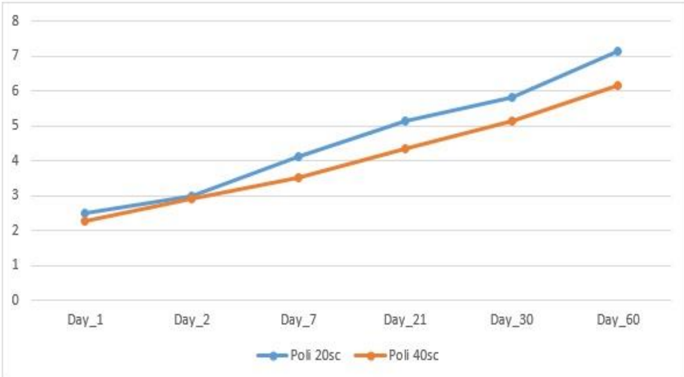
	Day_1			Day_2			Day_7			Day_21			Day_30			Day_60		
Poli.	Mean	St.	Med	Mean	St.	Med	Mean	St.	Med	Mean	St.	Med	Mean	St.	Med	Mean	St.	Med
20sc	2,49	2,56	1,28	3,00	2,95	2,06	4,13	4,29	3,24	5,15	5,37	3,93	5,81	5,64	4,60	7,13	7,11	6,11
40sc	2,28	2,20	1,56	2,90	2,76	1,83	3,52	3,45	2,83	4,35	4,36	2,96	5,14	4,89	3,66	6,16	6,00	4,83
p	0,92			0,88			0,74			0,72			0,66			0,69		

Table 3: Comparison of the coloration of the samples polymerized for 20 sec and 40 sec when the solutions are neglected.

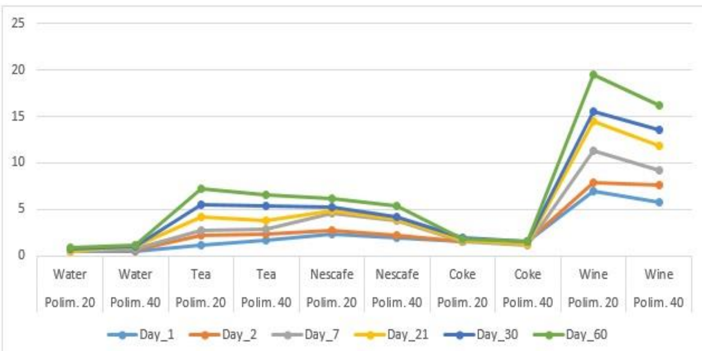


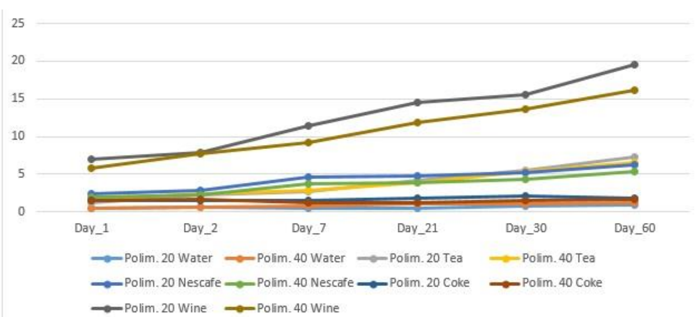
Graph 1: Differences in coloration according to the days formed by keeping the samples with different

polymerization times in water, tea, instant coffee, cola and red wine



Graph 2: Color differences according to days when solutions are ignored





Graph 3: Differences in coloration of samples kept in different solutions according to days.

Discussion

The most common reason for the restoration of composite resin restorations is the coloration seen in restorations [21]. These colorations may be due to the internal colorings caused by the structure of the resin, the contamination of the resin with blood or saliva, inadequate polymerization, faulty finishing and polishing processes, bad oral hygiene, smoking and diet as a result of exposure to various factors such as external coloration [21,22].

As a result of insufficient polymerization of composite resins in the clinic, water and organic polymer matrix react more easily to the water, resulting in increased water absorption, volume and weight of the composite [23]. For this reason, polymerization should be provided by the time period recommended by the manufacturers.

In a study conducted by Çelik et al. (2016), the samples were kept in coffee, wine, cola and distilled water for 3 months a day for a period of 1 hour and the red wine was measured in all coloring periods and the coffee was measured statistically in 1, 7 and 15 days color measurements according to the other color groups. showed significant differences [24].

The model, quality and polymerization time of the preferred light device for polymerization are significantly effective in the coloring of the composite resin [25,26]. Decrease in solubility with conversion of monomer to polymer and increase in dimensional stability leads to decrease in discoloration [27,28].

In recent studies, it has been reported that the internal coloring of the well-polymerized composite materials is lower [5,29]. Sufficient non-polymerized composite resins have been reported to undergo more color change when exposed to chemical dyes and food dyes [30,31].

Brackett et al (2007) in a study of quartz-tungsten-halogen (QTH) or blue light-emitting diode (LED) polymerized and Kamforokinon-containing composite resin materials, yellowish traces that occur and as a result of halogen (QTH) LED light It has been reported that it causes more yellowing in composite resins [28].

In a study Samra et al. (2008) performed with 71 samples using 5 different materials, no direct relationship was found between postpolymerization system and increased color stability [32].

In a study, the color stability of composite resins was investigated and composites and compomer samples of 2 mm thickness were formed. A group of samples were exposed to dark and 24 hours under UV light and 24 hours under water. The effect of various polymerization techniques on color changes in the study in the dark environment for 24 hours and 360 hours kept under the UV light for 24 hours and 360 hours more color change than the groups kept and more than the dark color has been reported and the additional polymerization in both composite and composite resins it has been reported to significantly reduce color change [33].

In our study, in order to see the effect of increasing the duration of polymerization of 2 groups polymerized over 20 sec and 40 sec in order to see the effect of coloration on coloration, in 5 different solutions (distilled water, tea, instant coffee, coke and red wine). 60 days and 1 day, 2 day, 7 day, 21st day, 30th day and 60th day color measurements were made by spectrophotometer.

When the coloration amounts were examined on average, samples kept in wine were observed on day 1, samples kept in instant coffee on day 7, and samples kept in tea were seen on day 21. Cola and distilled water in the samples held in the coloration was not seen. This is the same for both 20 sec and 40 sec polymerization cases. When the average difference for days for 20 sec and 40 sec polymerization measurements were examined, no coloration was seen in water and arm in days ($p > 0.05$), however, in all other solutions, coloration occurred over time.

When we examine the differences of the solutions which are the most important examination in this process according to the polymerization times for the same days; The only differences were obtained on the 7th day of the samples which were kept in the instant coffee and the average staining values of the samples applied for 40 sec polymerization were found to be statistically lower than the mean value of the polymerization samples applied for 20 seconds ($p = 0.035$). In all other cases, the results of 40 seconds of polymerization were generally less than average, but statistically significant differences were not obtained ($p > 0.05$).

Water and cola staining status can not be passed on any day followed by tea 21, 30, 60 and neskafenin 7., 21., 30., 60 days both 20 seconds and 40 seconds for the value of ΔE in the polymerization value higher than 3.1 has an average value. The coloration of the wine is always higher than 3.1 in every polymerization on all days.

Conclusion

As long as the polymerization is carried out in accordance with the rules, increasing the polymerization time does not have much effect on the coloration.

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