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Original Article

Evaluation of liquid sorption and color stability of dental composites after exposure to common lactation teas

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Abstract

Aim: To assess the effects of common lactation teas on liquid sorption and color stability of three different dental composites.

Methodology: A total of 60 samples (n = 5) were examined from three composite materials: Omnichroma (Tokuyama Dental Co., Tokyo, Japan), Estelite Posterior, (Tokuyama Dental Co., Tokyo, Japan), and Mosaic Universal (Ultradent production Inc., South Jordan, UT, USA). Samples measuring 2x6 mm were taken and immersed in three different teas—Humana (Humana, Bremen, Germany), Hipp, (Hipp, Pfaffenhofen, Germany), and Lactamil (Nutricia, Friedrichsdorf, Germany) —as well as artificial saliva. The measurements were recorded at baseline and on the 7th day. A sensitive analytical balance was used to measure liquid sorption, and a VITA Easy Shade device was used for color measurements. Absorption and Delta E values were calculated. The data were analyzed using MANOVA at a significance level of ($p<0.05$).

Results: Composite materials, solutions, and their interactions had a statistically significant effect on the sorption and Delta E values ($p<0.001$). The relative liquid absorption values among the composites were recorded as follows: Tokuyama>Mosaic>Omnichroma. Humana had the highest and Hipp had the lowest mean value among the solutions ($p<0.001$). For Delta E, Mosaic had the highest mean value among the composites, and Lactamil had the highest mean value among the solutions ($p<0.001$).

Conclusion: Lactation teas cause discoloration in dental composites. In vitro and in vivo studies on color changes in dental composites are needed due to the sorption of these fluids.

Keywords: sorption, color change, composite, lactation tea

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Introduction

Dental composites are affordable, aesthetic materials and are often preferred today (1). Composite restorations continuously interact with saliva and various fluids in the oral cavity. As a result of this interaction, the clinical life span of restorations is affected by alterations in both the physical and mechanical properties of composites (2).

For composites that are continuously exposed to various liquids, the amount of liquid absorption can be

important to compensate for polymerization shrinkage. However, composite expansion that cannot be compensated for affects the physical and mechanical properties, bond strength, and color stability of composites. The diffusion of liquids into composite structures is usually caused by the organic matrix of the material (3).

Color stability is required in restorations for aesthetic success. Color stability of composites is affected by many factors, such as the amount and structure of organic and inorganic fillers, photo-initiator contents, the light source used for polymerization, light application time, and the dietary habits of the patient (4).

Breast milk is a very important food for babies. However, when breast milk is insufficient, experts may recommend using breast milk-enhancing supplements or medications (5). Herbal teas recommended to nursing mothers can increase breast milk production in the first days after birth. It is recommended that these teas be consumed in servings of at least three cups a day (6). To the best of our knowledge, there are no studies showing the effects of lactation herbal teas on dental composite materials.

The aim of the present study was to evaluate the liquid sorption and color changes of different composite materials stored in three different lactation teas.

Materials and Methods

2.1 Specimen Preparation

Three different composite materials were used for the study: Omnichroma, Estelite Posterior, and Mosaic Universal (Table 1). A total of 60 2x6-mm samples (n=5) were prepared and polymerized with an LED curing light (Valo, Ultradent, South Jordan, UT, ABD). All samples were stored in artificial saliva for 24 hours. At the end of this period, five samples from each group were placed in Humana, Hipp, and Lactamil teas and artificial saliva (Table 2). According to the method of Gönülol and Yılmaz (2012), the liquids were renewed every 24 hours, and all samples were stored in an incubator at 37°C for seven days (7).

2.2 Liquid Sorption Measurement

Baseline and seven-day volumes for all samples were recorded using a caliper. A Pioneer (Ohaus, Pine Brook, USA) sensitive analytical balance, which can measure accurately to within 0.0001 gr, was used in weight measurements. Data were calculated using the formula " (m2-m1) / v " in µg / mm3 liquid absorption values.

2.3 Color Change Determination

A Vita Easy Shade spectrophotometer (Vita Zahnarzt, Germany) device was used for color measurement. The initial and seven-day value ΔE were calculated using the CIE 2000 system formulation:

$$\Delta E=\left(\left\{\Delta L * \frac{}{kLSL}\right\}^2+\left\{\Delta C * \frac{ab}{kCSC}\right\}^2+\left\{\Delta H * \frac{ab}{kHSH}\right\}^2+\Delta R\right)^{\frac{1}{2}}$$

Statistical analysis

The data were initially analyzed via multivariate analysis of variance (MANOVA) (SPSS software version 23, IBM SPSS Inc., Armonk, NY, USA) of the composites, liquids, and their interactions. Multiple comparisons were evaluated by the Bonferroni correction. The analysis results are presented as mean ± s. deviation. The significance level was ($p<0.05$).

Results

The liquid sorption and color change values of three different composite resin materials stored in lactation herbal teas were examined in our study. A comparison of the liquid sorption and ΔE values of the composites and liquids is shown in Table 3. The descriptive statistics for the ΔE and liquid sorption values of the composites and liquids are given in Table 4. The main effect for the composites was statistically significant for liquid sorption and ΔE ($p<0.001$). The main effect for the liquids was statistically significant for liquid absorption and ΔE values ($p<0.001$). Composite and liquid interaction effects were statistically significant for liquid sorption and ΔE values ($p<0.001$).

Table1. Summary of the resin composite products used in the study

Composite	Organic matrix	Filler Load	Color	Types
Omnichroma (Tokuyama Dental Co., Tokyo Japan)	UDMA, TEGDMA, mequinol, dibütil hidroksil toluen ve UV absorbents	w/w 79% v/v 68% spherical silica-zirconia	Universal	Supra-nano Spherical composite

Estelite Posterior, (Tokuyama Dental Co., Tokyo, Japan)	Bis-GMA, TEGDMA, BisMPEPP	w/w %84, v/v %70 silica-zirconia	A2	Nanohybrid
Mosaic Universal, (Ultradent production Inc., South Jordan UT, USA)	Bis-GMA	v/v %68 silica-zirconia glass-ceramic silica	A2	Nanohybrid

Table 2. Ingredients of the tested lactation tea

Lactation tea	Ingredients
Humana (Humana, Bremen, Germany)	Sucrose, maltodextrin, bamboo flower extract, vitamin c, raspberry leaf extract, lemongrass extract, fennel extract, roybos extract, fenugreek extract, goat psoriasis extract, fennel oil.
Hipp (Hipp, Pfaffenhofen, Germany)	Melissa extract, natural lemongrass aroma, nettle extract, caraway extract, anise extract, fennel extract, goat psoriasis extract.
Lactamil (Nutricia, Friedrichsdorf, Germany)	Rosehip, flavorings, beetroot, vitamins, fennel, anise, nettle out, chives cumin, stevia

Table 3. Comparison of liquid sorption and ΔE value of the composite and lactation tea

		F	p	Partial Eta Squared
Composite	Liquid sorption 7-01	674,0228	<0,001	,966
	ΔE 7-0 2	80,540	<0,001	,770
Lactation tea	Liquid sorption 7-0	130,090	<0,001	,890
	ΔE 7-0	274,584	<0,001	,945
*Composite * Lactation tea*	Liquid sorption 7-0	187,333	<0,001	,959
	ΔE 7-0	51,469	<0,001	,865

1R2 = ,980; 2R2=,956

Table 4. Descriptive statistics of liquid sorption and ΔE value of the composites and liquids

		Omnichroma	Mosaic	Estelite Posterior	Total
Liquid sorption	A. Saliva	26,25 ± 3,38	57,61 ± 2,12	57,23 ± 2,18	47,03 ± 15,41
	Humana	58,43 ± 3,67	67,57 ± 5,62	58,52 ± 2,47	61,51 ± 5,86
	Hipp	20,47 ± 3,66	26,74 ± 2,98	69,35 ± 4,77	38,85 ± 22,76
	Lactamil	29,86 ± 1,33	26,61 ± 1,16	94,14 ± 1,35	50,2 ± 32,21
	Total	33,75 ± 15,29	44,63 ± 19,03	69,81 ± 15,44	49,4 ± 22,38
ΔE	A. Saliva	5,52 ± 1,03	4,57 ± 1,7	2,62 ± 0,41	4,24 ± 1,66
	Humana	7,17 ± 0,56	12,97 ± 1,72	7,27 ± 1,18	9,14 ± 3,03
	Hipp	4,17 ± 0,78	2,57 ± 0,55	3,2 ± 0,44	3,31 ± 0,88
	Lactamil	7,16 ± 1,09	20,85 ± 1,4	13,51 ± 1,57	13,84 ± 5,92
	Total	6 ± 1,53	10,24 ± 7,56	6,65 ± 4,56	7,63 ± 5,42

The liquid sorption mean value of Estelite Posterior was statistically significantly higher than those of Mosaic and Omnichroma (Estelite Posterior>Mosaic>Omnichroma) ($p<0.001$). Although the ΔE value of Estelite Posterior was higher than that of Omnichroma, this difference was not statistically significant. The value of Mosaic was significantly higher than that of the other composites ($p<0.001$).

Although the liquid sorption value of artificial saliva was higher than that of Lactamil, the difference was not statistically significant. The sorption value of Humana was statistically significantly higher than those of other liquids ($p<0.001$). Hipp's mean value was significantly lower than that of other liquids ($p<0.001$). There was no significant difference between the ΔE mean value of the artificial saliva and that of Hipp. Whereas the mean value of Humana was higher than that of the other two teas, the mean value of Lactamil was significantly higher than that of all other liquids ($p<0.001$).

When the liquid sorption values of the composites and liquids were examined together, the mean value for Estelite Posterior composite stored in Lactamil was statistically significantly higher than that of the other groups. When composites and liquids were evaluated together in terms of ΔE values, the Mosaic composite stored in Lactamil had the highest mean value. Mosaic and Estelite Posterior composites stored in Lactamil liquid were statistically higher than other groups.

Discussion

There are many studies investigating color stability and fluid absorption in dental composites. Many studies have used liquids such as wine, tea, coffee, sports drinks, and fruit juices8. However, we have not come across any study examining the effect of lactation teas, which are widely recommended to breastfeeding mothers, on dental composites in recent years (5). Therefore, we chose to examine the effects of lactation teas on dental composites.

New composite materials are produced with new technologies for increasing aesthetic expectations. Coloration causes a decrease in the aesthetic properties of the dental composite (9). The organic matrix of composite resins significantly affects their color stability. UDMA and TEGDMA monomers in Omnichroma, Bis-GMA in Mosaic, Bis-GMA, and TEGDMA in Estelite Posterior were used in this study.

Previous studies reported that samples should be stored in artificial saliva or distilled water for 24 hours before being stored in coloring liquids to complete polymerization, achieve the expected liquid absorption, and adapt to oral conditions (11, 12).

In previous studies, composites were stored in liquids for short, medium, and long periods to evaluate liquid sorption and color change (13). However, it has been reported that the water absorption of composite resins reaches its highest level in 7-60 days (14).

It has been reported that keeping the composites in liquid at 37°C for 48 hours corresponds to 2 months in vivo conditions (7). In studies where liquids were renewed every day15, the maximum color change occurred at the end of the 7th day (9). Therefore, in our study, the liquids were renewed every 24 hours, and the samples were stored in the dark at 37oC for seven days. This period corresponds to a period of seven months

Munsell and CIE L * a * b * color systems are used for color measurement of materials used in dentistry. These have international validity, ease of use, and reliability. As a result, when the ΔE value is detected as 0, the color change in the material is considered constant; if it is less than (3.2), the color change cannot be detected visually and is clinically acceptable. However, if it is greater than (3.2), it is clinically unacceptable. In CIE L * a * b * system, all parameters are considered the same, but in CIE 2000, the

coefficients of the variables perceived by the eye are different from each other (17).

Herbal teas cause coloring on the dental composites (18). ΔE value has changed for all composite subgroups after retained in teas. The highest ΔE value was obtained in Lactamil, respectively, followed by Humana and Hipp fluid. Discoloration on the composites may be affected by the components of the teas. Lactamil liquid contains rosehip and beetroot. In the previous study, rosehip tea was reported to cause discoloration (19). In addition, the coloring effect of red beet on composite resins was observed (20, 21). We think that the increase in ΔE is due to the rosehip and red beet extracts in the Lactamil content.

The monomer can affect the fluid absorption and color stability of the dental composite. In previous studies, it was reported that the increase in the TEGDMA ratio increases the coloration, and the Bis-GMA monomer causes less coloration compared to TEGDMA. UDMA caused the least color change (26). However, in another study, it was stated that TEGDMA in the composite absorbed more liquid than UDMA and Bis-GMA and caused more color change (23). One study noted that Omnichoroma caused less discoloration due to UDMA. On the other hand, in another study conducted between monochrome Omnichroma and multicolor system composites, it was stated that the color change of Omnichroma was high25. Estelite Posterior with TEGDMA and Bis-GMA has the highest fluid absorption, similar to other studies (18, 23). The Mosaic containing Bis-GMA showed the greatest color change, unlike previous studies (18,23). The Omnichroma containing TEGDMA and UDMA showed the lowest color change and absorption. The reason for this may be UDMA organic matrix and inorganic supra-nano structure like in previous studies. Therefore, more studies are needed on the Omnichroma composite. Therefore, more studies are needed on the Omnichroma composite.

As in other in vitro studies, there are several limitations in our study. There are factors affecting the restorations in the oral cavity, such as saliva circulation and microbiota, pH change, and temperature change. Therefore, the oral cavity could not be imitated exactly. Although the samples were polished in equal time while preparing, their surface roughness could not be evaluated. In our study, three different liquids were used with three different composites. However, we think that new studies are needed with various liquids and composites with different content.

Conclusions

In this study, Humana, Hipp, and Lactamil herbal teas that increase breast milk exhibited different fluid absorption and color change on all composites on the 7th day, depending on the material. The highest color change was recorded in Mosaic stored in Lactamil; the highest fluid absorption was recorded in Estelite held in Lactamil. The lowest color change and fluid absorption were recorded in samples stored in artificial saliva, while the highest values were recorded in Lactamil. Consumption of herbal teas that increase breast milk may affect the clinical aesthetic and mechanical properties of restorations, so dentists should be careful in choosing materials for nursing mothers using these teas.

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