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Effects of Beverages Frequently Consumed By Children on Color Stability of Fiber-Reinforced Resin Crowns

Çocukların Sıklıkla Tükettiği İçeceklerin, Fiberle Güçlendirilmiş Rezin Kronların Renk Stabilitesi Üzerine Etkileri

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Abstract

Aim To evaluate the effect of five different beverages most frequently consumed by children in terms of color change (ΔE) on fiber rein-forced resin crowns.

Material and Method In this study, fiber reinforced resin crowns (Figaro Crowns, Inc., Woodbury, MN, USA) produced for a total of 60 maxillary upper central incisors were used. After the initial color values were measured with a spectrophotometer device, the crowns were randomly divided into six groups: the first group was the control group, the 2nd group was cola, the 3rd group was peach flavored ice tea, the 4th group was cherry juice, the 5th group was orange juice, and the 6th was chocolate milk. (n=10). Crowns were incubated in drinks for one week. After the test period, the color measurements of the crowns, which were washed with distilled water and air-dried, were repeated and the color change values were calculated. One-way analysis of variance (ANOVA) was used to evaluate the effect of beverages on color change. Tukey test was performed for pairwise comparisons. The statistical significance threshold was accepted as p=0.05.

Results All crowns showed color change after beverage exposure, statistically significant differences were found between the groups ($p < 0.05$). The highest ΔE values were observed in the ice tea group, while the lowest ΔE values were observed in the control group. While a significant difference was observed between the cola, ice tea and cherry juice groups and the control group (p=0.02, p=0.00, p=0.001), no significant difference was found in the orange juice and chocolate milk groups ($p > 0.05$).

Conclusion It is important to inform patients and parents about the discoloration that may occur after beverage consumption in order to maintain color stability, especially in cases where anterior teeth are restored with fiber-reinforced resin crowns

Keywords Fiber rein-forced resin crown, beverage coloring, color change, spectrophotometer

Özet

Amaç *Çocukların en sık tükettiği beş farklı içeceğin fiberle güçlendirilmiş rezin kronlar üzerinde renk değişimi (ΔE) bakımından etkisini değerlendirmektir.*

Gereç ve Yöntem *Bu çalışmada, toplamda 60 adet maksiller üst santral kesici diş için üretilmiş fiberle güçlendirilmiş rezin kron (Figaro Crowns, Inc., Woodbury, MN, USA) kullanıldı. Başlangıç renk değerlerinin spektrofotometre cihazı ile ölçülmesinin ardından kronlar ilk grup kontrol grubu, 2. grup kola, 3. grup şeftali aromalı soğuk çay, 4. grup vişne suyu, 5. grup portakal suyu ve 6. grup çikolatalı süt olmak üzere rastgele altı gruba ayrıldı (n=10). Kronlar bir hafta boyunca içecekler içerisinde inkübe edildi. Test periyodu sonrası distile su ile yıkanan ve kurutulan kronların renk ölçümleri tekrarlandı ve renk değişim değerleri hesaplandı. İçeceklerin renk değişimi üzerindeki etkisinin değerlendirilebilmesi için tek yönlü varyans analizi (ANOVA) kullanıldı. İkili karşılaştırmalar için Tukey testi yapıldı. İstatistiksel anlamlılık eşiği p=0,05 olarak kabul edildi.*

Bulgular *Bütün kronlar, içecek maruziyeti sonrasında renk değişikliği gösterdi, gruplar arasında istatistiksel olarak anlamlı farklılık tesbit edildi ($p < 0,05$). Değerlendirmeler sonucu en yüksek ΔE değerleri soğuk çay grubunda izlenirken en düşük ΔE değerleri kontrol grubunda gözlendi. Kola, soğuk çay ve vişne suyu grubu ile kontrol grubu arasında anlamlı farklılık izlenirken (p=0,02, p=0,00, p=0,001), portakal suyu ve çikolatalı süt gruplarında anlamlı farklılık bulunmadı ($p > 0,05$).*

Sonuç *Çocuklarda özellikle ön dişlerin fiberle güçlendirilmiş rezin kronlarla restore edildiği durumlarda, renk stabilitesinin devamlılığı için hasta ve ebeveynlerin içecek tüketimi sonrası oluşabilecek renklenmeler konusunda bilgilendirilmesi önem taşımaktadır.*

Anahtar Kelimeler *Fiberle güçlendirilmiş rezin kron, içecek renklenmesi, renk değişimi, spektrofotometre*

INTRODUCTION

It is recommended to use full coronal restorations in the treatment of extensive, polyhedral and subgingival carious lesions observed in primary teeth[1,2]. For this purpose, stainless steel crowns (PPCs) have been used for many years and are still considered the gold standard[3,4]. However, in addition to the many advantages they provide, PPCs cannot meet the aesthetic expectations of children and parents[5,6]. As a result of developments in ceramic and resin technology, more aesthetically acceptable restorations have been produced as an alternative to PCCs[5,7,8]. Today, the most preferred aesthetic crowns are zirconia crowns available from different manufacturers, and the clinical success of these crowns has been documented in comparison with other options[5,9,10]. However, these crowns have disadvantages such as being very sensitive to the technique, requiring excessive preparation to provide a passive fit, and high microhardness, while not allowing the desired physiological wear in primary teeth, but causing abrasions in antagonistic teeth[11,12]. To overcome these disadvantages, fiber reinforced resin crowns have been introduced as an alternative[13].

Fiber-reinforced composites are frequently used in various dental applications due to their good mechanical properties, easy application, relative flexibility and high adjustability, as well as superior aesthetic properties[14-16]. Fiber-reinforced resin crowns are tooth-coloured. In addition, they have lower wear resistance than zirconia crowns and require less tooth preparation[13]. There are few studies in the literature on these crowns used in the restoration of primary teeth[13,17].

In children, color changes that occur over time, especially in anterior teeth restorations, pose a problem for the patient and the parents[18]. Since visuality is at the forefront of the social environment, the interest of individuals in aesthetics has increased. Tooth discoloration in pediatric dentistry has become a problem that needs to be prevented, with the increase in children's concerns about their appearance[19]. Colorations may be due to external or internal causes. Extrinsic discolorations can be mainly caused by adsorption and absorption of coloring agents found in food and beverages. Surface quality, hydrophilicity, thermal stress and pH value in the oral environment are among the factors that can affect the degree of adsorption and absorption[20]. In addition, the effect of various external factors on discoloration in pediatric dentistry has been reported in the literature[21-28].

In particular, acidic beverages cause deterioration of the organic matrix structure of restorations and the formation of porous areas[29]. Afterwards, the color pigments in the food and beverages penetrate these porous areas and color changes can be observed in the restorations[30]. Although many studies have evaluated the effect of beverages frequently consumed by children on the coloration of aesthetic restorations[21-23,31,32], there are no studies examining the effects of such beverages on the color stability of fiber-reinforced resin crowns. Therefore, in the present study, it was aimed to evaluate the effect of five different beverages consumed most frequently by children in terms of color change on fiber reinforced resin crowns.

MATERIAL and METHODS

In the present study, fiber reinforced resin crowns (Figaro Crowns, Inc., Woodbury, MN, USA) produced for a total of 60 maxillary upper central incisors were used. The sample size was calculated by using G*Power version 3.1.9.4 (Heinrich Heine, University of Düsseldorf, Düsseldorf, Germany) with a power of 90%. In the estimation, a supposed significance level of 0.05 and an effect size of 0.2533 were applied. Regarding the number of the groups (as 6), a total of 60 crowns were used to obtain 10 specimens at the each subgroups. The surface of the crowns was washed with distilled water for 5 seconds and gently air-dried. Afterwards, the color value of each crown was measured using a spectrophotometer device (Vita EasyShade, Ivoclar Vivadent, Liechtenstein) and these values were recorded as the initial value. A spectrophotometer device was cal-

ibrated for every 10 measurements. The measurement was performed by placing the tip of the device vertically in the middle of the vestibule surface of each sample. All measurements were made under D65 standard lighting conditions using a white background. Measurements were repeated three times for each sample and the average was recorded. Afterwards, the samples were randomly divided into six groups (n=10) and kept in different beverages for one week (distilled water, cola, ice tea, cherry juice, orange juice, chocolate milk). The first group was distilled water as the control group, the second group included cola (Coca-Cola, The Coca-Cola Company, Istanbul, Turkey), the third group included peach flavored ice tea (Lipton Ice Tea, Turkey), the fourth group included cherry juice (Dimes, Istanbul, Turkey), the fifth group was included orange juice (Dimes, Istanbul, Turkey), group sixth was determined as chocolate milk (Danone, Istanbul, Turkey). The immersion solutions were renewed every day during the seven-day test period. Samples were added to freshly prepared drinks. After the seven-day incubation period, color measurements were repeated for each sample as previously described and recorded according to the CIE L*a*b* system.

The CIE L*a*b* system is the most widely used method for measuring color values. In the 3D color coordinate system; L* describes the difference between light (L*=100) and dark (L*=0), a* describes the difference between green (-a*) and red (+a*), b* describes the difference between blue (-b*) and yellow (+ b*). The color change value (ΔE) for each crown was calculated using the following formula:

$(L^*a^*b^*) = ([\Delta L^*]\ 2 + [\Delta a^*]\ 2 + [\Delta b^*]2)\ ½$

ΔL*: is the difference between the L* values.

Δa*: is the difference between the a* values.

Δb*: is the difference between the b* values.

As stated in the study of Vichi et al.34, the threshold for detectability of color changes and the threshold for clinical acceptability was determined as ΔE=1 and ΔE=3.3, respectively, in the present study.

Statistical analysis

Statistical software (SPSS 22; IBM, Armonk, NY, USA) was used for data analysis. The effect of beverage factors on color change was evaluated by two-way analysis of variance (ANOVA). Tukey's HSD post hoc test was used to determine the differences between the groups. The results were evaluated at the p≤0.05 significance level.

RESULTS

The average color change (ΔE*) determined by soaking the fiber reinforced resin crowns in different beverages is shown in Table 1. ΔE values range from 1.14 to 4.9 on average for all beverages. The highest color change was observed in ice tea, and the least color change was observed in the samples kept in distilled water. The color change in the crowns kept in distilled water and chocolate milk drinks was above the detection threshold (ΔE>1) but at a clinically acceptable (ΔE<3.3) level. The color change in the crowns kept in cola, ice tea, cherry juice and orange juice was clinically unacceptable (ΔE>3.3)(Table 1, Figure 1).

Table 1. Color changes (mean standard±deviation) after immersion in children's drinks.

Beverages	Distiled water	Cola	Ice tea	Cherry juice	Orange juice	Chocolate milk
Δ*E* values of Fiber crowns	1.14±0.4[b]	3.78±2.3[a]	4.9±2.8[a]	4.65±1.6[a]	3.37±1.3 [a,b]	2.72±1.1 [a,b]

Different superscript letters in the same line indicate statistically significant difference (p < 0.05). Significant differences were found between the distilled water group and the cola, ice tea and cherry juice groups (p=0.02, p=0.00, p=0.001). There was no significant difference between the other groups (p >0.05).

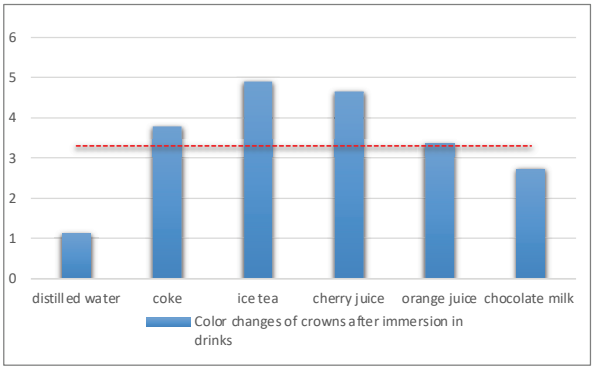

Figure 1. Color changes of crowns after immersion in drinks

It was observed that there was a statistically significant difference between the drinks in which the crowns were kept in terms of coloration ($p<0.05$). The color changes in cola, ice tea and cherry juice were found to be statistically significantly higher compared to distilled water, respectively ($p=0.02$, $p=0.00$, $p=0.001$). There was no significant difference between the color change of the crowns kept in orange juice and chocolate milk and the color change of the crowns kept in distilled water ($p>0.05$).

DISCUSSION

Tooth-colored restorative materials tend to discolor when continually exposed to food and drink. In pediatric dentistry, the long-term color stability of restorations is important as it can cause behavioral management problems in children as a result of multiple dental visits, in addition to aesthetic reasons and the additional costs paid for the replacement of restorations35. For this reason, many studies have been conducted to investigate the color stability of restorative materials used in children[23,36-38].

It is known that the coloration of intraoral tissues and restorations is affected by dietary factors. In studies examining the color stability of restorative materials, frequently consumed beverages such as tea, coffee, cola, and red wine, which are generally associated with adult discoloration, have been used[39-41]. Although there are a limited number of studies in the literature evaluating the discoloration of beverages frequently consumed by children on restorations[23,36-38], no study has been found examining the coloring effect of these beverages on fiber-reinforced resin crowns. Therefore, in the present study, it was aimed to fill the gap in the literature about the color stability of fiber-reinforced resin crowns used for restorative purposes in beverages frequently consumed by young age group individuals.

In their study, Ertaş et al.[42] stated that keeping the colorant drinks for 24 hours is equivalent to approximately one month. In the present study, similar to the study of Oliveria et al.[43], color change was investigated for more than six months with a seven-day immersion period.

The pH values of the drinks used in this study were 3.5 (peach flavored ice tea), 3.88 (orange juice), 3.5 (cherry juice), 6.76 (chocolate milk) and 2.7 (cola). Studies have shown that cola and fruit juices lose their gas one week after the lid is opened, but the pH value does not change[44,45]. In dentistry, color changes in aesthetic materials can be made by using color analysis devices as well as visual examinations. The use of digital colorimeters is recommended to minimize discrepancies in color perception and differences between researchers[46]. Devices such as colorimeter and spectrophotometer have been reported to be reliable for color measurement in dental material studies[47]. In the present study, color measurements were calculated with the CIE Lab system using a spectrophotometer, since it is reproducible and sensitive to small color changes[48]. This system is related to the ability of the human eye to detect color differences. It proposed three threshold ranges: $\Delta E < 1$ undetectable to the human eye, $1.0 < \Delta E < 3.3$ distinguishable by an expert, and $\Delta E > 3.3$ easily observable to the naked eye. ΔE values above the 3.3 threshold are defined as clinically unacceptable[49]. According to the results of the current study, the color change in the cola, ice tea, cherry juice and orange juice groups was clinically unacceptable after a seven-day immersion period ($\Delta E > 3.3$).

Of the beverages tested, ice tea caused the most discoloration on the fiber reinforced resin crowns. Ice tea, which is one of the important parts of the ready-to-drink beverage industry especially for children, is obtained by flavoring the hot tea with various fruits (especially lemon and peach are common) and then cooling it after adding sugar. In their study, Güler et al.[40] examined the effects of black tea on coloration and reported that the addition of sugar increased the coloring effect of tea. Yellow pigment adhesion in tea is thought to increase with the addition of sugar[40]. In the study of Lopes et al.[36] in which they examined the coloring effect of children's beverages on restorative materials, they reported that ice tea caused the most coloring among the coloring agents, similar to the results of the current study. The ΔE values in the crowns tested in our study were ordered as ice tea > cherry juice > cola > orange juice > chocolate milk > distilled water.

In the present study, ice tea was found to have a high coloring capacity compared to cola and other beverages. In the study of Um and Ruyter[50], it was reported that although cola deterotes the surface integrity of restorative materials due to its low pH, it does not cause color change as much as tea because it does not contain the yellow colorants found in tea. Several studies[40,51] examining the same qualities have shown that tea has a greater coloring effect on restorative materials than cola.

Tunç et al.[23], in their study examining the sensitivity of different restorative materials to coloration, explained that chocolate milk caused less coloration than other beverages, and this was due to the difference in pH values of the beverages evaluated. Similarly, in the study of Lopes et al.[36], it was proven that chocolate milk has the lowest coloring effect of all the materials examined. In the results of the present study, supporting the results of other studies, it was observed that chocolate milk caused the least coloration among all the evaluated beverages and this coloration was at a clinically acceptable level. This is thought to be due to the high pH of chocolate milk compared to other beverages.

In addition to the beverages evaluated in this study; Factors such as the washing effect of saliva, consumed food and beverages, brushing habits, and poor oral hygiene can affect the discoloration of restorations used in the mouth. The inability to create ideal experimental conditions that provide all these factors is one of the limitations of this study.

It has been determined that the coloration of the fiber reinforced resin crowns varies according to the type of beverage. When the beverages were evaluated, the most color change occurred in ice tea. Cola, ice tea, cherry juice, and orange juice caused clinically unacceptable discoloration on fiber-reinforced resin crowns. Chocolate milk caused perceptible but clinically acceptable coloration.

It is important for physicians to warn parents about the discoloration of the crowns that may occur as a result of their children's beverage consumption, especially in cases where the anterior teeth are restored with fiber-reinforced resin crowns due to excessive loss of substance. However, there is a need for long-term clinical studies that will contribute to the results of this in-vitro study evaluating the color changes of fiber-reinforced crowns.

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Conflict of interest

There is no conflict of interest between the authors.

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