Selcuk Dental Journal 10/3 (Aralık 2023): 560-564

Research Article / Araştırma Makalesi

The Effect of Beverages and Polishing on Discoloration of Different Provisional Prosthetic Materials: An *in Vitro* Study

İçeceklerin ve Polisajın Farklı Geçici Protetik Materyallerin Renk Değişimine Etkisi: *in Vitro* Çalışma

Ayşe RENÇBER KIZILKAYA[α](ORCID-0000-0002-0377-7953), **Meltem Nermin DURSUN**[β](ORCID-0000-0002-5857-7326)

[α]Fırat University, School of Dentistry, Department of Prosthodontics, Elazığ, Türkiye

[α]Fırat Üniversitesi Diş Hekimliği Fakültesi Protetik Diş Tedavisi AD, Elazığ, Türkiye

[β]Izmir Democracy University, School of Dentistry, Department of Restorative Dentistry, İzmir, Türkiye

[β]İzmir Demokrasi Üniversitesi Diş Hekimliği Fakültesi Restoratif Diş Tedavisi AD, İzmir, Türkiye

ABSTRACT

Objective: The aim of this study was to evaluate the effect of five different beverages and polishing on the color change of two different temporary prosthetic materials manufactured with different methods.

Method: 160 (10x2 mm) disc-shaped samples were fabricated using direct (Acrytemp)(n=80) and indirect (Imident) (n=80) temporary prosthetic materials. Samples prepared using molds were divided into four groups as polished (direct/indirect material) and unpolished (direct/indirect material) (n=40 each). After initial measurement of L,a,b values using a spectrophotometer, the samples in each group were immersed in five different beverages (distilled water (DW), coffee (CF), cola (CC), sour cherry juice (CJ), red wine (RW) (n=8) and stored for 7 days. Then, the spectrophotometric measurements of the samples were repeated and the color change (ΔE_{00}) values were calculated. Data were analyzed using a three-way-ANOVA followed by post hoc Tukey HSD test (p=0.05).

Results: Greater color change was observed in the direct temporary material (p<0.05). A statistically significant difference was found between polished and unpolished samples (p<0.05). There was no significant difference between indirect and direct temporary materials in terms of discoloration in the CC and DW groups (p>0.05). Indirect temporary material exhibited less color change than their direct counterparts in the RW, CJ, CF groups (p<0.05). Less color change was observed in the polished groups (except DW) in direct temporary materials (p<0.05). Color change values were lower in the CC and DW groups compared to CF group (p<0.05). Comparing the direct temporary material groups, the greatest color change value was found in the RW group (p<0.05).

Conclusion: Although variations in color change can be observed depending on the contents of the temporary materials and the beverages utilized, surface polishing of the material contributes to a reduction in color change.

Keywords: Bis-acryl, Color stability, Polishing, Polymethylmethacrylate, Temporary prosthetic materials

ÖZ

Amaç: Bu çalışmanın amacı, yapım teknikleri farklılık gösteren iki geçici protetik materyal üzerinde beş farklı içeceğin ve polisajın renk değişimine olan etkisini değerlendirmektir.

Yöntem: 160 adet (10x2 mm) disk şeklinde numune, direkt (Acrytemp) (n=80) ve indirekt (Imident) (n=80) geçici protetik materyaller kullanılarak elde edildi. Kalıp kullanılarak hazırlanan numuneler, polisaj işlemi uygulanan (direkt/indirekt materyal) ve uygulanmayan (direkt/indirekt materyal) olarak dört ayrı gruba bölündü(n=40). İlk L, a, b değerleri bir spektrofotometre kullanılarak ölçüldükten sonra, her bir gruptaki numuneler beş farklı içeceğe (distile su (DW), kahve (CF), cola (CC), vişne suyu (CJ), kırmızı şarap (RW)) daldırıldı ve bir hafta süre ile bekletildi. Ardından numunelerin spektrofotometrik ölçümleri tekrarlandı ve renk değişimi (ΔE_{00}) değerleri belirlendi. Verilerin analizleri üç yönlü ANOVA ve ardından post hoc Tukey HSD testleri ile yapıldı (p=0.05).

Bulgular: Direkt geçici materyalde daha belirgin bir renk değişimi gözlendi (p<0.05). Polisaj uygulanan ve uygulanmayan numuneler arasında önemli farklılık bulundu (p<0.05). CC ve DW gruplarında, direkt ve indirekt geçici materyaller arasında anlamlı bir farklılık bulunmadı (p>0.05). RW, CF, CJ gruplarında, indirekt geçici materyal direkt geçici materyalden daha az renk değişim değeri gösterdi (p<0.05). Direkt geçici materyallerde DW hariç, polisaj uygulanan gruplarda daha az renk değişimi bulundu (p<0.05). CC ve DW gruplarında, CF grubuna göre daha düşük renk değişimi değerleri izlendi (p<0.05). Direkt geçici materyal grupları karşılaştırıldığı zaman, RW grubunun renk değişim değeri en yüksek bulundu (p<0.05).

Sonuç: Geçici materyallerin yapım tekniklerine ve kullanılan içeceklere bağlı olarak meydana gelen renk değişiminde farklılıklar izlense de materyalin yüzeyine polisaj uygulanması renk değişiminin azalmasına yönelik katkıda bulunmaktadır.

Anahtar Kelimeler: Bis-akril, Geçici protetik materyaller, Polimetilmetakrilat, Polisaj, Renk stabilitesi

INTRODUCTION

In dentistry, temporary restorations are used as an interim material between the time of tooth preparation and the placement of permanent prosthetic restorations [1-4]. These restorations protect the prepared dental structure against thermal and mechanical factors and provide aesthetic and functional rehabilitation of the oral environment. Therefore, it is desirable for these materials to show sufficient wear resistance, mechanical strength and color stability to meet aesthetic and biological requirements [2, 5]. In addition, temporary restorations offer several advantages such as prevention of bacterial contamination, protection of pulpal and periodontal tissues, and maintenance of the normal position of the tooth, all of which are essential at this intermediate stage [1]. These restorations assist in the planning of the form and function of the definitive prosthetic restorations and allow for a diagnostic assessment before the fabrication of the final restoration [3, 6, 7]. The quality of the interim treatment restoration largely affects the prognosis of fixed prosthetic restoration. Thus, temporary restorations are intended to simulate definitive restorations as much as possible [6].

Traditionally, temporary restorations have been fabricated using two different methods, direct and indirect. Currently, with the advances in digital technologies, additive and subtractive methods enable easier manufacturing of restorations that are more similar to the actual final restorations. Producing indirect restorations on plaster provides the dental practitioner with better visibility of margins for contouring and polishing restorations. Direct fabrication of temporary restorations for multiple teeth is also a commonly used technique [8, 9].

Temporary restorations can be used for a short time, such as a few days, or they can be kept in the oral cavity for a longer period if necessary [10]. Preservation of color stability of the materials is highly demanded by patients, especially in long-term use and/or for aesthetic reasons

Gönderilme Tarihi/Received: 15 Nisan, 2023
Kabul Tarihi/Accepted: 14 Haziran, 2023
Yayınlanma Tarihi/Published: 25 Aralık, 2023
Atıf Bilgisi/Cite this article as: Rençber Kızılkaya A, Dursun MN. The Effect of Beverages and Polishing on Discoloration of Different Provisional Prosthetic Materials: An *in Vitro* Study. Selcuk Dent J 2023;10(3): 560-564
Doi: 10.15311/ selcukdentj.1283984

Sorumlu yazar/Corresponding Author: Ayşe RENÇBER KIZILKAYA
E-mail: ayserencber23@hotmail.com
Doi: 10.15311/ selcukdentj.1283984

[7, 11, 12]. Discoloration of temporary restorations leads to patient dissatisfaction and may require replacement of the restoration [13]. Color stability of temporary restorations is affected by numerous factors, including the chemical and physical characteristics of the material, inadequate polymerization, water absorption, oral hygiene, dietary habits and surface roughness [7, 13, 14].

Exposure to various coloring agents may cause discoloration of the surface of the temporary restorative materials [3, 7, 12]. The presence of rough surfaces increases the staining potential of restorations [15, 16]. The aim of this in vitro study was to investigate the influence of five commercially available beverages and polishing procedure on the color change of direct and indirect temporary prosthetic materials. The null hypotheses tested were as follows: (1) the test beverages will not have any effect on discoloration of the color of temporary materials, (2) there will be no difference between the direct and indirect temporary materials regarding color change, and (3) polishing will not affect discoloration of the temporary materials.

MATERIALS AND METHODS

Sample size calculation

G*Power, version 3.1 (Heinrich-Heine Dusseldorf University, Dusseldorf, Germany) was used to compute the sample size. Power analysis showed that a minimum of five samples in each group would be required to achieve a power of 81% with 95% confidence interval and an effect size of 0.50 . Ultimately, eight samples were included in each group.

Sample Preparation

A total of 160 disc-shaped samples were fabricated using indirect (Imident, Imicryl, Konya, Turkey) and direct (Acrytemp, Zhermack SPA, Italy) temporary restoration materials (n=80). Direct restorative material was applied through a dispensing gun using disposable tips, and indirect provisional material was prepared as a powder-liquid mixture as recommended by the manufacturer and allowed to set in. The materials were meticulously inserted into a silicone mold (10 mm in diameter and 2 mm in thickness), and subsequently covered by a glass slide to ensure uniformity and accuracy of the sample. Excess material was removed by applying gentle pressure to obtain a flat surface. After completion of chemical polymerization, the samples were removed from the mold. Then, the samples were randomly separated into two groups categorized as polished and unpolished (n=40 each). (**Table1**)

Table 1. Study groups

DIRECT MATERIALS		INDIRECT MATERIALS	
POLISHED(n:40)	UNPOLISHED(n:40)	POLISHED(n:40)	UNPOLISHED(n:40)
DW(n:8)	DW(n:8)	DW(n:8)	DW(n:8)
CC(n:8)	CC(n:8)	CC(n:8)	CC(n:8)
CF(n:8)	CF(n:8)	CF(n:8)	CF(n:8)
CJ(n:8)	CJ(n:8)	CJ(n:8)	CJ(n:8)
RW(n:8)	RW(n:8)	RW(n:8)	RW(n:8)

The polished samples were prepared with 600-grit silicon carbide abrasive paper under water cooling for 10 seconds. Then, a mixture of pumice powder and water was applied to the sample surfaces with a bristle brush for 1 minute. Finally, polishing was completed by applying a polishing paste (Universal Polishing Paste, Ivoclar Vivadent, Schaan/Lichtenstein) to the samples with a cotton brush for 1 minute. Finishing and polishing procedures were performed by a single, experienced operator to avoid bias. The unpolished samples were not subjected to any kind of surface treatment after they were removed from the mold. All samples with or without polishing were stored in distilled water for 24 hours.

Immersion of the Samples in Solutions

After removing the samples from the distilled water, initial color measurements were obtained using a spectrophotometer. The samples were divided into five subgroups according to the different test beverages (n=8 each): DW (Distilled water), CC (Coca-Cola, the Coca-Cola Company, İstanbul, Turkey), CF (Coffee, Nescafe Gold, Nestle Corp., Vevey, Switzerland), CJ (Sour cherry juice, Dimes Gıda A.S., İzmir, Turkey), RW (Red wine, Kavaklıdere Wines Co., Ankara, Turkey). Distilled water was utilized as the control group in this study. Details of the materials used are listed in **Table 2**.

Table 2. Beverages and provisional materials used in the study

Product	Manufacturer	Components
Coca-Cola (CC)	The Coca-Cola Company, Istanbul, Turkey	Carbonated water, high-fructose corn syrup (HFCS), caramel color, phosphoric acid, natural flavors, caffeine.
Coffee (CF)	Nescafe Gold, Nestle Corp., Vevey, Switzerland	Soluble coffee, finely ground coffee (3%).
Sour cherry juice (CJ)	Dimes Gıda A.S, İzmir, Turkey	Water, sugar (sucrose/fructose-glucose syrup), sour cherry juice concentrate, acidity regulator (citric acid), Flavoring (sour cherry).
Red Wine (RW)	Kavaklıdere Wines Co., Ankara, Turkey	Boğazkere grape, Carignan grape, Alicante grape, Öküzgözü grape, Alcohol (13.5% vol), egg albumin, sulphites.
Imident (indirect)	Imicryl, Konya, Turkey	Polymethyl methacrylate
Acrytemp (direct)	Zhermack SPA, Via Bovazecchino, Italy	Bis-acrylic composite resin

To prepare the coffee solution, 2 g coffee granules were added to 200 ml of boiling water. The solution was ready for use after a waiting period of 10 minutes to achieve drinking temperature [17]. Other solutions were also prepared in a 200 ml cup size. The samples were immersed in respective solutions for one week and the solutions were renewed daily [18]. After storage for a week, the samples were removed from the solutions, rinsed with distilled water, dried with a paper towel, and then second color readings were obtained.

Color Measurements

Spectrophotometric readings were taken before and after immersion in different coloring solutions. All color measurements were obtained on a standard white surface using a digital spectrophotometer (Vita Easyshade V, VITA Zahnfabrik GmbH&Co. KG, Germany). Measurements were recorded according to the CIELAB Color System, which was first introduced in 1978 by the Commission Internationale de l'Eclairage to describe color based on human perception [12]. This system consists of three spatial coordinates designated as L* (lightness), a*(green-red axis), and b*(yellow-blue axis). After three measurements were taken, the mean values for L*a*b* were recorded, and color change (ΔE_{00}) was calculated using the new CIEDE2000 formula [19, 20].

As widely adopted by the dental professionals, the parametric factors in the color difference formula were set at 1 and $\Delta E_{00} \leq 1.8$ units was selected as the clinically acceptable color difference threshold in this study[21, 22].

Statistical Analysis

SPSS 21.0 for Windows (IBM Corp., Armonk, NY) was used for the analysis of the study data. The normality of the data distribution was checked using Kolmogorov-Smirnov and Shapiro-Wilk tests. Analysis of normally distributed data was conducted using three-way ANOVA. Pairwise comparisons were made using post hoc Tukey HDS test. Significance was evaluated at the $p<0.05$ level.

RESULTS

The results of three-way ANOVA analysis and ΔE_{00} values (mean ± SD) of the groups are shown in **Tables 3** and **4**, respectively. After immersion in the solutions for one week, direct provisional material showed greater color change than indirect provisional material ($p<0.05$). A significant difference was observed between the polished and unpolished samples ($p<0.05$). The five different beverages tested showed significant differences with each other in terms of color change ($p<0.05$).

Table 3. Three-way ANOVA results of the effects of interest (provisional material, polishing and beverage) and interactions among these effects

ΔE_{00}	Type III Sum of Squares	df	Mean Square	F	p
Provisional Material	767.172	1	767.172	275.361	0.000*
Polishing	303.352	1	303.352	108.882	0.000*
Beverage	1.347.309	4	336.827	120.897	0.000*
Provisional Material x Polishing	135.374	1	135.374	48.59	0.000*
Provisional Material x Beverage	741.727	4	185.432	66.557	0.000*
Polishing x Beverage	174.744	4	43.686	15.68	0.000*
Provisional Material x Polishing x Beverage	92.123	4	23.031	8.266	0.000*

Three-way ANOVA *$p<0.05$

Table 4. ΔE_{00} values of the groups

Provisional Material	Polishing	DW	CC	CF	CJ	RW	^1p
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Direct	Polished	0.55±0.36^{D}	0.69±0.39^{D}	6.19±1.0^{B}	2.90±0.71^{C}	9.02±2.17^{A}	0.000*
	Unpolished	0.59±0.24^{D}	1.47±0.77^{D}	13.63±3.73^{B}	8.48±2.29^{C}	18.16±4.21^{A}	0.000*
	^2p	0.800	0.028*	0.001*	0.000*	0.000*	
Indirect	Polished	0.40±0.10^{B}	1.10±0.84^{BC}	2.33±1.04^{A}	1.24±0.71^{AB}	1.57±0.79^{AC}	0.000*
	Unpolished	0.49±0.13^{B}	1.52±0.80^{BC}	3.75±1.46^{A}	2.30±2.07^{AB}	3.16±1.31^{AC}	0.000*
	^2p	0.175	0.325	0.042*	0.193	0.011*	
Direct Indirect	Polished ^3p	0.295	0.230	0.000*	0.000*	0.000*	
	Unpolished ^3p	0.324	0.888	0.000*	0.000*	0.000*	

Three-way ANOVA *$p<0.05$
Different superscript letters in the same row indicate a significant difference among the groups.
^1p: Comparison among the beverages.
^2p: Comparison between polished and non-polished restorations.
^3p: Comparison among the provisional materials.

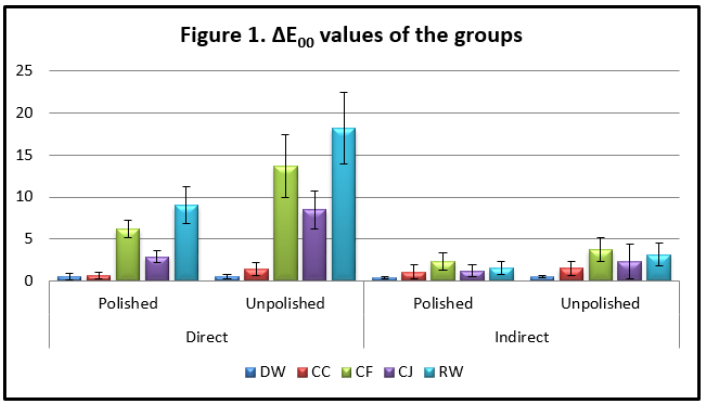

Figure 1. ΔE_{00} values of the groups

No significant difference was observed between indirect and direct temporary materials in the CC and DW groups ($p>0.05$). In RW, CJ, CF groups, less color change was seen in the indirect temporary material compared to the direct material ($p<0.05$). In the direct temporary materials, except for the DW group, the polished groups showed lower color change values ($p<0.05$). When comparing indirect temporary materials with or without polishing, statistically significant differences were only observed in the RW and CF groups ($p<0.05$). Color change values were lower in the CC and DW groups compared to CF group ($p<0.05$). Among the direct temporary material groups, the RW group displayed the greatest color change value ($p<0.05$). In the direct temporary material, the CF group showed more color change than the CJ group ($p<0.05$), while similar values were observed in the indirect temporary material ($p>0.05$).

DW and CC groups showed similar ΔE_{00} values ($p>0.05$) and did not exhibit clinically perceptible color change in direct and indirect materials ($\Delta E00<1.8$) . In polished indirect temporary material, only the CF group showed unacceptable color change ($\Delta E_{00}>1.8$). The RW, CJ and CF groups showed unacceptable color change in direct and polished indirect materials ($\Delta E_{00}>1.8$).

DISCUSSION

Temporary restorations designed for use in the interval between tooth preparation and placement of the definitive prosthesis are expected to retain their aesthetic properties throughout their use. Color stability of temporary materials is of great importance for both patients and clinicians, especially for aesthetic concerns or in the case of extensive prosthodontic treatment where it must be kept in oral cavity for six months or even longer [7, 11, 23]. For this reason, in this study, the samples were immersed in staining solutions for a test period of 7 days to simulate one year of beverage consumption with exposure of the oral cavity to the beverages for 30 minutes a day [18]. After 7 days of immersion in the beverages, clinically unacceptable color changes were seen in the CF, CJ and RW groups ($\Delta E_{00}>1.8$) [24]. However, no clinically perceptible color change was observed in the DW and CC groups ($\Delta E_{00}<1.8$). As a result, the first null hypothesis was partly rejected.

Materials available for fabricating temporary restorations contain autopolymerizing polymethyl methacrylate (PMMA), polyvinyl methacrylate, urethane methacrylate, polyethylene methacrylate, micro-filled resin and bis-acryl. Polyethylene methacrylate has poor aesthetics and wear resistance which resulted in a larger market share for polymethyl methacrylate and bis-acryl resin composite materials [25]. Studies have shown that PMMA-based provisional materials tend to exhibit less discoloration than other temporary resins, including bis-acrylic resin [7, 12, 26, 27]. Doray et al.[28] found that MMA (methyl methacrylate)- based material provides superior color stability. Gujjari et al. [29] and Mazaro et al. [30] reported that PMMA displayed lower color change levels in contrast to bis-acrylic resin. Yannikakis et al. [31] noted that while MMA-based materials showed the best color stability, bis-acryl composite materials showed the worst. These findings can be attributed to the heterogeneous structure of composite-based materials as opposed to acrylic-based materials which have a homogeneous structure. The capacity to adsorb and absorb solutions directly affects the color stability of homogeneous PMMA-based materials. However, the heterogeneous structure of bis-acryl resins allows the pigmenting solution to infiltrate into the midst of the small particles of the material and this causes greater color change in the material [23, 27, 30]. In addition, bis-acryl resins are more polar than PMMA materials, resulting in a greater affinity for water and other polar liquids. This may explain the degree of color change of most bis-acryl resins [12]. In this study, direct temporary material with bis-acryl and indirect temporary material with PMMA were compared and it was seen that PMMA material provided better color stability in line with the literature. In light of these results, it can be considered that choosing a PMMA-based material would be advantageous if temporary restorations are to remain in the oral cavity for a long time [23]. In this study, it was demonstrated that the type of material significantly affects the color stability of temporary materials, and therefore, the second null hypothesis was rejected.

It is desirable to render the restoration surfaces as smooth as possible with finishing and polishing procedures. This is important not only for satisfactory aesthetic outcomes but also for oral health. Rough surfaces make the material more susceptible to staining compared to smooth surfaces, causing retention of microorganisms and plaque accumulation and compromising the clinical performance of the entire restoration [14, 23]. Although provisional materials are used at the intermediate stage before placement of the definitive prosthesis, polishing of the surface of the temporary materials is essential. The results of this study also show the importance of polishing the surfaces. In addition, the same surface properties may not be achieved in every material after polishing. It has been reported that MMA-based materials display smoother surfaces after polishing compared to bis-acryl resin [14, 23, 31, 32]. The greater color change seen in the direct temporary material used in this study may be related to the

surface properties of the bis-acrylic materials. In this study, less discoloration was observed in the polished temporary materials than their unpolished counterparts. Thus, the third null hypothesis was rejected.

Several factors such as surface roughness, poor oral hygiene and intake of coloring foods and beverages may cause discoloration of the tooth and restoration surfaces [14, 33]. In this study, a comparison of beverages frequently consumed by individuals (cola, coffee, sour cherry juice, red wine) was made. The findings of this study show that there was no perceptible color change in the CC group (ΔE_{00}<1.8). While the CJ group showed less discoloration in the direct restorative material than RW and CF groups ($p<0.05$), a similar color change was observed in the indirect material ($p>0.05$). The greatest color change in the direct temporary material was seen in the RW and CF groups ($p<0.05$). Red wine and coffee cause discoloration of the surface through surface adsorption and absorption of staining particles. Previous studies have reported that red wine causes the greatest color change in temporary restorative materials [11, 14]. Mazaro et al.[30] reported that the coffee solution caused a significant color change. In addition, consistent with the current study, they reported that cola did not cause a significant color change, which was attributed to the absence of a yellow coloring agent in its content [30].

This study has some limitations. The samples used in this study had a flat surface, while temporary restorations had an irregular shape with concave and convex surfaces. Moreover, materials that are placed in the oral environment are exposed to many factors, such as saliva, consumption of a wide variety of foods and beverages, smoking, poor oral hygiene, which may contribute to discoloration of the temporary material. Therefore, further studies are needed to evaluate temporary prosthodontic restorations in vivo.

CONCLUSION

The greatest color change value was observed after the unpolished restorative material was immersed in red wine. No clinically perceptible discoloration was observed in distilled water and coca cola groups. Within the limitation of this study, although variations in color change were observed depending on the beverages utilized the methods used for manufacturing the temporary materials, the current findings indicate that surface polishing of the material contributes to a reduction in color change. It can be concluded that indirect restorative materials have better color stability than direct materials.

Değerlendirme / Peer-Review

İki Dış Hakem / Çift Taraflı Körleme

Etik Beyan / Ethical statement

Bu makale, TDB 26. Uluslararası Dişhekimliği Kongresi'nde sözlü olarak sunulan ancak tam metni yayımlanmayan "Farklı İçeceklerin ve Polisajın Direkt ve İndirekt Geçici Restoratif Materyallerin Renk Değişimine Olan Etkisinin In Vitro Değerlendirilmesi" adlı tebliğin içerigi geliştirilerek ve kısmen değiştirilerek üretilmiş hâlidir.

Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.

This article is the version of the presentation named "In Vitro Evaluation of The Effects of Different Beverages and Polishing on The Color Change of Direct and Indirect Provisional Restorative Materials", which was presented orally at the TDB 26th International Dental Congress, but whose full text was not published, by improving and partially changing the content.

It is declared that during the preparation process of this study, scientific and ethical principles were followed and all the studies benefited are stated in the bibliography.

Benzerlik Taraması / Similarity scan

Yapıldı – ithenticate

Etik Bildirim / Ethical statement

ethic.selcukdentaljournal@hotmail.com

Finansman / Grant Support

Yazarlar bu çalışma için finansal destek almadığını beyan etmiştir. | The authors declared that this study has received no financial support.

Çıkar Çatışması / Conflict of Interest

Yazarlar çıkar çatışması bildirmemiştir. | The authors have no conflict of interest to declare.

Yazar Katkıları / Author Contributions

Çalışmanın Tasarlanması | Design of Study: ARK (%50), MND (%50)
Veri Toplanması | Data Acquisition: ARK (%50), MND (%50)
Veri Analizi | Data Analysis: ARK (%50), MND (%50)
Makalenin Yazımı | Writing up: ARK (%50), MND (%50)
Makale Gönderimi ve Revizyonu | Submission and Revision: ARK (%50), MND (%50)

REFERENCES

1. Abdullah AO, Tsitrou EA, Pollington S. Comparative in vitro evaluation of CAD/CAM vs conventional provisional crowns. J Appl Oral Sci. 2016;24(3):258-63.
2. Song SY, Shin YH, Lee JY, Shin SW. Color stability of provisional restorative materials with different fabrication methods. J Adv Prosthodont. 2020;12(5):259-64.
3. Burns DR, Beck DA, Nelson SK, Committee on Research in Fixed Prosthodontics of the Academy of Fixed P. A review of selected dental literature on contemporary provisional fixed prosthodontic treatment: report of the Committee on Research in Fixed Prosthodontics of the Academy of Fixed Prosthodontics. J Prosthet Dent. 2003;90(5):474-97.
4. Maiti S. Comparative Analysis of Colour Stability in Relation to Different Temporization Materials Using Toothbrush Simulator and the Microbial Adhesion to these Materials-An in vitro Study.
5. RAJPUT R, HASTI A, CHOUDHARY A, DUGGAL S, ALI S. Comparative Evaluation of Flexural Strength and Surface Roughness of Three Different Commercially Available Provisional Restorative Materials: An In-vitro Study. Journal of Clinical & Diagnostic Research. 2022;16(1).
6. Jalali H, Dorriz H, Hoseinkhezri F, Emadian Razavi SF. In vitro color stability of provisional restorative materials. Indian J Dent Res. 2012;23(3):388-92.
7. Coutinho CA, Hegde D, Sanjeevan V, Coutinho IF, Priya A. Comparative evaluation of color stability of three commercially available provisional restorative materials: An in vitro study. J Indian Prosthodont Soc. 2021;21(2):161-6.
8. Mayer J, Stawarczyk B, Vogt K, Hickel R, Edelhoff D, Reymus M. Influence of cleaning methods after 3D printing on two-body wear and fracture load of resin-based temporary crown and bridge material. Clinical Oral Investigations. 2021;25:5987-96.
9. Sari T, Usumez A, Strasser T, Şahinbas A, Rosentritt M. Temporary materials: comparison of in vivo and in vitro performance. Clinical oral investigations. 2020;24:4061-8.
10. Patel A, Sethuraman R, Prajapati P, Patel J, Naveen Y. A comparative analysis of staining characteristics of mouthrinses on provisional acrylic resin: An in vitro study. Journal of Interdisciplinary Dentistry. 2013;3(3):167.
11. Guler AU, Yilmaz F, Kulunk T, Guler E, Kurt S. Effects of different drinks on stainability of resin composite provisional restorative materials. J Prosthet Dent. 2005;94(2):118-24.
12. Haselton DR, Diaz-Arnold AM, Dawson DV. Color stability of provisional crown and fixed partial denture resins. J Prosthet Dent. 2005;93(1):70-5.
13. Sham AS, Chu FC, Chai J, Chow TW. Color stability of provisional prosthodontic materials. J Prosthet Dent. 2004;91(5):447-52.
14. Rutkunas V, Sabaliauskas V, Mizutani H. Effects of different food colorants and polishing techniques on color stability of provisional prosthetic materials. Dent Mater J. 2010;29(2):167-76.
15. Soares IA, Leite P, Farias OR, Lemos GA, Batista AUD, Montenegro RV. Polishing Methods' Influence on Color Stability and Roughness of 2 Provisional Prosthodontic Materials. J Prosthodont. 2019;28(5):564-71.
16. Guler AU, Kurt S, Kulunk T. Effects of various finishing procedures on the staining of provisional restorative materials. J Prosthet Dent. 2005;93(5):453-8.
17. Alofi RS, Alsuayri HA, Mohey LS, Alofi AS. Efficiency of activated charcoal powder in stain removal and effect on surface roughness compared to whitening toothpaste in resin composite: In vitro study. Saudi Dent J. 2021;33(8):1105-10.
18. Barbosa GF, Cardoso MB. Effects of carbonated beverages on resin composite stability. Am J Dent. 2018;31(6):313-6.
19. Paravina RD, Ghinea R, Herrera LJ, Bona AD, Igiel C, Linninger M, et al. Color difference thresholds in dentistry. J Esthet Restor Dent. 2015;27 Suppl 1:S1-9.
20. Gómez-Polo C, Martín Casado AM, Quispe N, Gallardo ER, Montero J. Colour Changes of Acetal Resins (CAD-CAM) In Vivo. Applied Sciences. 2023;13(1):181.
21. Tinastepe N, Malkondu O, Iscan I, Kazazoglu E. Effect of home and over the contour bleaching on stainability of CAD/CAM esthetic restorative materials. Journal of Esthetic and Restorative Dentistry. 2021;33(2):303-13.
22. Celik N, Iscan Yapar M. Colour stability of stained composite resins after brushing with whitening toothpaste. International Journal of Dental Hygiene. 2021;19(4):413-20.
23. Turgut S, Bagis B, Ayaz EA, Ulusoy KU, Altintas SH, Korkmaz FM, et al. Discoloration of provisional restorations after oral rinses. Int J Med Sci. 2013;10(11):1503-9.
24. Celik N, Iscan Yapar M. Colour stability of stained composite resins after brushing with whitening toothpaste. Int J Dent Hyg. 2021;19(4):413-20.
25. Almohareb T, Alkatheeri MS, Vohra F, Alrahlah A. Influence of experimental staining on the color stability of indirect computer-aided design/computer-aided manufacturing dental provisional materials. Eur J Dent. 2018;12(2):269-74.
26. Crispin BJ, Caputo AA. Color stability of temporary restorative materials. J Prosthet Dent. 1979;42(1):27-33.
27. Mickeviciute E, Ivanauskiene E, Noreikiene V. In vitro color and roughness stability of different temporary restorative materials. Stomatologija. 2016;18(2):66-72.
28. Doray PG, Li D, Powers JM. Color stability of provisional restorative materials after accelerated aging. J Prosthodont. 2001;10(4):212-6.
29. Gujjari AK, Bhatnagar VM, Basavaraju RM. Color stability and flexural strength of poly (methyl methacrylate) and bis-acrylic composite based provisional crown and bridge auto-polymerizing resins exposed to beverages and food dye: an in vitro study. Indian J Dent Res. 2013;24(2):172-7.
30. Mazaro JVQ, Minani LM, Zavanelli AC, Mello CCd, Lemos CAA. Evaluation of color stability of different temporary restorative materials. Revista de Odontologia da UNESP. 2015;44:262-7.
31. Yannikakis SA, Zissis AJ, Polyzois GL, Caroni C. Color stability of provisional resin restorative materials. J Prosthet Dent. 1998;80(5):533-9.
32. Sen D, Goller G, Issever H. The effect of two polishing pastes on the surface roughness of bis-acryl composite and methacrylate-based resins. J Prosthet Dent. 2002;88(5):527-32.
33. Mârțu I, Murariu A, Baciu ER, Savin CN, Foia I, Tatarciuc M, et al. An Interdisciplinary Study Regarding the Characteristics of Dental Resins Used for Temporary Bridges. Medicina. 2022;58(6):811.