



Effect of Different Polishing Systems and Drinks on the Color Stability of Resin Composite

Aslı Berber, Filiz Yalcin Cakir, Meserret Baseren, Sevil Gurgan

ABSTRACT

Aim: The purpose of this study was to evaluate the color stability of resin composite using different finishing systems and drinks.

Materials and methods: Composite disks (5 mm diameter, 2 mm thickness) were prepared for each nanofilled composite using a brass mold. The specimens were divided into 5 finishing system groups Mylar strip (Mylar, DuPont, Wilmington, Del., USA), Soft Lex (3M™ ESPE™ St. Paul, MN, USA), Enhance (Dentsply-DeTrey GmbH Konstanz, Germany), Hiluster (KerrHawe, Bioggio, Switzerland), Opti Disc (KerrHawe, Bioggio, Switzerland) and each group was divided into 10 subgroups (n = 10) and stored for 24 hours at 37°C in different drinks water coffee, coffee with sugar, tea, tea with sugar, diet coke, coke, light sour cherry juice or sour cherry juice. Color of all specimens was measured before and after exposure with a spectrophotometer using CIE L*a*b* relative, and color changes (ΔE^*) were then calculated. The data were analyzed with a two-way analysis of variance (ANOVA), and mean values were compared by the Tukey HSD test ($p = 0.05$).

Results: For the drinks, the lowest ΔE^* values were observed in the water and highest ΔE^* values were observed in sour cherry juice. When drinks with and without sugar were compared, all groups with sugar demonstrated a higher color difference than without sugar. For the different finishing systems, Mylar strip group demonstrated significantly highest color change; Enhance groups demonstrated significantly lowest color change.

Conclusion: Finishing treatments and storage solutions significantly affect the color stability of resin composite. The presence of sugar in drinks increased the color difference compared to drinks without composite.

Clinical significance: Polishing techniques and drinking drinks with sugar may affect the color of esthetic restorations.

Keywords: Polishing systems, Drinks, Color, Resin composites.

How to cite this article: Berber A, Cakir FY, Baseren M, Gurgan S. Effect of Different Polishing Systems and Drinks on the Color Stability of Resin Composite. *J Contemp Dent Pract* 2013; 14(4):662-667.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Resin composites have been widely used in dentistry since 1960s when they were first described.¹ The popularity of tooth colored restoration has increased due to esthetic needs of patients and developments in resin technology.²

Also, the survival rate and clinical success of composite resins are important in restorative dentistry and they may be related to the surface texture.³ The esthetic aspect of tooth-colored restorative materials is partly dependent on surface roughness. A rough surface increases plaque retention, which may then result in gingival inflammation, superficial staining, secondary caries and color change.⁴ The smoothness of restorative material's surface has great importance in the success and clinical longevity of the restorations.⁵ Both esthetic and clinical success of restorations strongly depend on the quality of the surface finishing and polishing.⁶ A well polished surface can reduce plaque accumulation, gingival irritation, poor esthetic and color change due to the fact that the finishing and polishing are important steps in restorative dentistry.^{7,8} Many studies have reported that the surface feature of composite restorations may be influenced by different surface finishing treatments.⁹⁻¹¹

Esthetic failure is one of the most common problems for the evaluation of clinical performance of resin composites. Discoloration and marginal degradation are two reasons why restorations are replaced.¹² Color changes in resins occur from intrinsic and extrinsic factors.¹³ Discoloration of resin composites may be caused by intrinsic or extrinsic factors. Intrinsic factors involve the discoloration of the resin material itself, such as the alteration of the resin matrix and of the interface of the matrix and the fillers. Extrinsic factors for discoloration include staining by adsorption or absorption of colorants as

a result of contamination from exogenous sources. The degree of discoloration from exogenous sources varies according to the oral hygiene, the eating-drinking and smoking habits of the patient.^{14,15} Several studies have been conducted to determine the effects of staining solutions on the surface characteristics of esthetic restorative materials.¹⁶⁻¹⁸

Composite structure and the characteristics of the inorganic fillers may influence the quality of the composite surface, and can therefore be related to the discoloration of composite.¹⁹ In recent years nanofill and nanohybrid composites have been produced with innovative nanotechnology resulting in new microhybrid composites being available now in the dental marketplace.²⁰ Nanocomposites possess high translucency, high polish, and polish retention similar to microfills, while having physical properties and wear resistance equivalent to some hybrids.²¹

The discoloration of resin composites appears to be related to multiple factors such as incomplete polymerization, water sorption, chemical reactivity, diet, oral hygiene, and surface smoothness of the restoration.²²

There is a lack of information in the few studies reporting on the effect of both different polishing systems and drinks on color change of nanofilled resin composites. The effect of sugar in the drinks on color difference of resin composite has not been completely clarified. Therefore, the purpose

of our research was to evaluate the color stability of nanohybrid resin composite, exposure to different polishing system and different drinks.

MATERIALS AND METHODS

Five different polishing systems and ten different solutions and their effects on the color change of A2 shade resin composite were evaluated. The polishing systems and drinks used in this study are shown in Tables 1 and 2.

Specimen Preparation

Five hundred nanofilled composite disk samples in A2 shade (Dentsply-DeTrey GmbH Konstanz, Germany), a diameter of 15 mm and a thickness of approximately 2 mm were prepared using a metal mold. The mold with the composite resin was held between 2 glass slides, each covered with a transparent polyester strip (Mylar, DuPont, Wilmington, Del. USA) and the microscope slides were gently pressed together to remove excess material. All specimens were polymerized by a LED light-curing unit Elipar Free Light 2 (3M ESPE, St Paul, MN, USA) with light intensity of 1000 mW/cm², using 20 seconds of exposure to top and bottom surfaces, respectively. The distance between the light source and the specimen was standardized by the use of a 1 mm glass slide. The end of the light guide was in contact

Table 1: The polishing systems used in this study

Polishing systems	Composition	Manufacturers
Mylar Strip (Control Group)	Universal strips	Mylar, DuPont, Wilmington, Del., USA
Sof-Lex™ Contouring and Polishing Discs Kit	Medium aluminum oxide disks (40 μm) Fine aluminum oxide disks (24 μm) Ultra Fine aluminum oxide disks (8 μm)	3M™ ESPE™ St Paul, MN, USA Batch no: 0815418
Enhance Composite Finishing and Polishing Systems	Aluminum oxide disks Fine aluminum oxide paste Ultra fine aluminum oxide disks	Dentsply-DeTrey GmbH D Konstanz, Germany) Batch no: 0703291
Hiluster ^{PLUS} Polishing Systems	Aluminum oxide particles embedded into a silicone elastomer (mean particle size: 20 microns) HiLusterPlus Dia Polisher: silicone carbide and diamond particles (5 microns) embedded into a silicon elastomer	KerrHawe, Bioggio, Switzerland Batch no: 2880665
Opti Disk	Medium aluminum oxide disks (40 μm) Fine aluminum oxide disks (20 μm) Ultra Fine aluminum oxide disks (10 μm)	KerrHawe, Bioggio, Switzerland Batch no: 70701950

Table 2: Drinks used in this study

Drinks	Compositions/Manufacturer
Water	Distilled water (Control group)
Water with sugar	Distilled water with sugar (10 gm sugar added for every 300 ml water)
Coffee	Nescafe Classic Nestle, Istanbul Turkey
Coffee with sugar	Nescafe 3 in 1 Coffee with artificial creamer and sugar Nestle, Istanbul Turkey
Tea	Yellow Label Tea, Lipton, Rize Turkey 2 prefabricated doses (2 x 2 gm) of tea into 300 ml of boiling distilled water for 10 minutes.
Tea with sugar	Yellow Label Tea, Lipton, Rize Turkey (10 gm sugar added for every 300 ml tea)
Coke	The Coca-cola Co, Istanbul, Turkey
Sour cherry juice	Cappy Special, The Coca-cola Co, Istanbul, Turkey

with the cover glass during the light polymerization process. On completion of specimen fabrication, the disks were randomly divided into five polishing groups (n = 100). The specimens were finished and polished by a single investigator, according to the manufacturer's instructions.

Polishing Procedures

Group 1: Mylar Strip (Mylar, DuPont, Wilmington, Del. USA): This group comprised the specimens that were not submitted to finishing and polishing procedures and kept untreated.

Group 2: Sof-Lex™ Contouring and Polishing Disks Kit (3M™ ESPE™ St Paul, MN, USA): Sof-Lex discs at medium, fine, and super-fine grits were used for 30 seconds each on the specimens. After each step of polishing, the specimens were thoroughly rinsed with water and air-dried before the next step until final polishing.

Group 3: Enhance Composite Finishing and Polishing Systems (Dentsply-DeTrey GmbH Konstanz, Germany): Enhance finishing disks were applied 15 seconds for the intermedia finishing and a foam polishing cup with Prisma Gloss fine and super fine polishing pastes were then applied for 15 seconds. Specimens were thoroughly rinsed with water and air-dried between and after polishing paste application.

Group 4: Hiluster^{PLUS} Polishing Systems (KerrHawe, Bioggio, Switzerland): Hiluster Gloss polisher were applied 20 second for the finishing then Hiluster Dia Polisher 20 second for the polishing. Specimens were thoroughly rinsed with water and air-dried between and after polishing application.

Group 5: OptiDisc (KerrHawe, Bioggio, Switzerland): The disks were used for 30 seconds each on the specimens. Operations in this group was the same as group 2.

All prepared specimens were then stored in distilled water at 37°C for 24 hours for rehydration and completion of the polymerization. The colors of all specimen groups were measured before exposure to staining medias with a spectrophotometer (Vita Easy Shade, Vident Brea, CA, USA) using CIE L*a*b* (Commission International de l'Éclairage) relative to standard illuminant, against a white background.

Staining Procedures

Then each group was divided into 10 subgroups as following; distilled water, distilled water with sugar, coffee, coffee with sugar, tea, tea with sugar, diet coke, coke, diet sour cherry juice, sour cherry juice. Disk specimens from

each material were immersed in each of the ten staining solutions indicated in Table 2 at 37°C and for 24 hours. The distilled water group was used as control.

Color Measurements

After 24 hours, the specimens were rinsed with distilled water and blotted dry with a tissue paper before re-measurements.

The CIE (Commission International de l'Éclairage) system uses the three-dimensionless colorimetric measurements. L* characterizes the lightness of the color and can be ranged between 0 (dark) and 100 (light); a* defining a color on a red-green axis; and b* describing the blue part of the color. Values were recorded using the Commission International de l'Éclairage L*a*b color system. For each sample, three repeated measurements were taken to determine the colorimetric values. The mean values of ΔL , Δa and Δb after three measurements were automatically calculated by colorimeter and recorded. The total color difference ΔE for each disk sample was calculated using the following equation: $\Delta E = (\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2$.^{2,3}

STATISTICAL ANALYSIS

The mean and standard deviations of ΔE^* were determined. Data were analyzed using two-way analysis of variance (ANOVA). Two-way ANOVA, $p \leq 0.005$ was calculated for the differences between the groups one-way ANOVA and Tukey HSD test $p \leq 0.005$ used to detect specific differences within each group.

RESULTS

The ΔE values are shown in Table 3. The effect of polishing systems and drinks on the color stability of resin composite was statistically significant ($p = 0.001$).

Polishing systems; when comparing polishing systems without drinks; Mylar strip group demonstrated significantly highest color change and enhance group demonstrated significantly lower color change ($p < 0.001$) than the other polishing systems tested for all drinks. There were no statistically significant differences among other polishing systems tested ($p = 0.642$).

Drinks; when comparing drinks without polishing systems; The lowest ΔE values were observed in the water while the highest color difference was observed in the sour cherry juice ($p < 0.001$). ΔE was significantly higher for coke, coffee than tea. When drinks with and without sugar were compared, all groups with sugar demonstrated a higher color change than the groups without sugar ($p < 0.001$).

Table 3: Color change values (ΔE)

Drinks	Polishing systems				
	Mylar strip (Group 1)	Soft lex (Group 2)	Enhance (Group 3)	Hiluster (Group 4)	Optidisc (Group 5)
Water	1.14	0.45	0.27	0.69	0.50
Water with sugar	1.33	1.14	1.03	1.22	1.18
Tea	5.69	4.11	4.02	3.88	4.75
Tea with sugar	7.98	6.11	5.64	4.96	5.95
Coffee	11.40	10.88	8.32	10.40	10.12
Coffee with sugar	13.52	11.41	10.53	11.59	11.64
Diet coke	12.54	11.06	10.37	11.54	10.12
Coke	14.35	13.26	11.11	12.50	12.11
Diet sour cherry juice	15.45	11.55	10.72	12.72	10.76
Sour cherry juice	16.84	13.42	12.09	14.36	14.12

DISCUSSION

The discoloration of tooth colored resin-based composite materials may be a reason for the replacement of dental restorations in esthetic areas. This process concerns patient and dentist and consumes time and money.

Color stability of resin composites may be considered as a significant criterion in the selection of a material for use in an aesthetic ally critical area.²³ The use of composite resins in restorative dentistry became routine with the improvement of mechanical and physical properties of the resin systems.²⁴ The size of filler particles is an important parameter that has been used to characterize the restorative material for purposes of clinical applications.²⁵ The latest development in the resin composites has been the introduction of nanofill particles and nanoclusters in resin matrix. An increase in filler content procedures smoother surface because of the lower particle size and better distribution within the resin matrix.^{26,27}

Many studies have reported that color change and surface texture of nanofilled composites are better than the other microfilled or hybrid composites. Berger et al²⁵ have reported Filtek Supreme Plus nanofilled resin composite presented surface that were more stain resistant than those of the enamel microfill and esthet X composites for all polishing systems. Topcu et al¹⁴ have reported that the least color changes were seen with coffee, coke, cherry juice, red wine and artificial saliva in filtek supreme nanofilled resin composites when compared with the other microfilled or microhybrit composites. The nanofilled composite Ceram X duo were used in this study that comprises organically modified ceramic nanoparticles and nanofillers combined with conventional glass fillers.

The structure of a resin composite and the characteristics of particles may have a direct impact on surface smoothness and the susceptibility to staining. The finishing and polishing procedures may also influence the composite surface.¹⁵ Several studies have been reported in the literature

evaluating the effect of various finishing and polishing systems on the surface roughness of resin composites but a few studies have been reported on the relationship between polishing systems and color changes. That is why we have chosen different polishing systems and different drinks. Proper finishing and polishing have been related smooth surface, less plaque retention and discoloration, thus esthetic of the restorations.²⁶ In this study we evaluated aluminum oxide disks and polishing paste and we found that enhance polishing paste group better than the other polishing disks and pastes. This results were not in agreement with the fact that some studies reported aluminum oxide disks were the best instruments for producing smooth surface restorations compared to abrasive impregnated disks. Also a study by Herrgott et al.²⁷ using scanning electron microscope, reported Sof-LexTM disks produced smoothest surface finish.

Mylar polyester matrix strips have been used to produce standardized specimens and these specimens have been cured under Mylar strips, as well as being used as controls in several studies.^{3,23,25} Pratten and Johnson²⁸ and Stoddard and Johnson²⁹ found that polyester film finishing produced the smoothest surfaces. One should expect a polyester film-finished surface to exhibit the least amount of staining. However, polyester-film finishing exhibited the greatest color change in this study. This situation can be explained as follows: the use of a polyester film strip not only results in a smooth surface finish, but also eliminates the presence of an uncured layer on the surface.

In this study we have used spectrophotometer CIE L*a*b* coordinates system and with the reference in other studies. CIE L*a*b* system was chosen to evaluate color variation (ΔE) because it is well suited for small color changes determination and have advantages such as repeatability, sensitivity and objectivity.^{14,15,19,23}

Coffee was chosen as a staining solution in the present study because it has shown a high capacity of staining resin composite.¹⁹ Coffee may stain both by adsorption and by

absorption of its colorants onto/into the organic phase of the resin composites.¹⁴ Composite resins that can absorb water are also able to absorb other fluids with pigments, which results in discolorations. It is assumed that water acts as a vehicle for stain penetration into the resin matrix.¹⁹

Coke drink does not appear to be strongly implicated in color change of composites, despite the presence of phosphoric acid. Acids behave differently in promoting dissolution and hence in eroding the materials. In addition, the presence of phosphate ions in coke may suppress the dissolution since these ions have been shown to reduce the dissolution rate of calcium phosphate from the tooth.¹⁴⁻¹⁹

The effect of sugar on color difference of nanofilled resin composite has not been yet fully understood. According to the results of present study, the presence of sugar in drinks increased color difference. The reason for this may be the sticky effect of sugar on the staining of drinks.²²

Guler et al²² used coffee and tea as staining agents and found that coffee stained provisional resin restorative materials more than tea. In another study by Mohan et al³⁰ tea, coffee, and snuff were used as chromogenic agents, and coffee was found to stain more than tea and snuff. Also, in the present study, coffee was found to stain more than tea. The results of this study are consistent with results of the other studies. We demonstrated that the effect of the staining solutions was different for various materials.

CONCLUSION

Finishing treatments and storage solutions significantly affect the color stability of resin composite. The presence of sugar in drinks increased the color difference compared to drinks without composite.

CLINICAL SIGNIFICANCE

Polishing techniques and drinking drinks with sugar may affect the color of esthetic restorations.

REFERENCES

1. Betsy KM, Renata DMC, Ambonib, Luiz Henrique M, Pratesc, José RB, Alfredo TN. Influence of drinks on resin composite: evaluation of degree of cure and color change parameters. *Poly Testing* 2007;26(4):438-444.
2. Baseren NM. Surface roughness of nanofill and nanohybrid composite resin and ormocer-based tooth-colored restorative materials after several finishing and polishing procedures. *J Biomater Appl* 2004; 19(2): 121-134.
3. Arslan S, Yazici AR, Görücü J, Pala K, Antonson DE, Antonson SA, Silici S. Comparison of the effects of ER,CR:YSGG laser and different cavity disinfection agents on microleakage of current adhesives. *Lasers Med Sci* 2011 Aug 19. (Epub ahead of print)
4. Ozel E, Korkmaz Y, Attar N, Karabulut E. Effect of one-step polishing systems on surface roughness of different flowable restorative materials. *Dent Mater J* 2008;27(6):755-764.
5. Yazici AR, Tuncer D, Antonson S, Onen A, Kilinc. Effects of delayed finishing/polishing on surface roughness, hardness and gloss of tooth-coloured restorative materials. *Eur J Dent* 2010; 4(1):50-56.
6. Scheibe KGBA, Almeýda KGBA, Medeyros IS, Costa JF, Alves CMC. Effect of different polishing systems on the surface roughness of microhybrid composites. *Appl Oral Sci* 2009; 17(1):21-26.
7. Barbosa SH, Zanata RL, De Lima Navarro MF, Nunes OB. Effect of different finishing and polishing techniques on the surface roughness of microfilled, hybrid and packable composite resins. *Braz Dent J* 2005;16(1):39-44.
8. Fýlho HN, D'azevedo MTF, Nagem HD, Marsola FP. Surface roughness of composite resins after finishing and polishing. *Braz Dent J* 2003;14(1):37-41.
9. Kameyama A, Nakazawa T, Haruyama A, Haruyama C, Hosaka M, HiraY. Influence of finishing/polishing procedures on the surface texture of two resin composites. *The Open Dent J* 2008; 2: 56-60.
10. Aykent F, Yondem I, Ozyesil AG, Gunal SK, Avunduk MC, Ozkan S. Effect of different finishing techniques for restorative materials on surface roughness and bacterial adhesion, *J Prost Dent* 2010; 103(4): 221-227.
11. Scheibe KG, Almeida KG, Medeiros IS, Costa JF, Alves CM. Effect of different polishing systems on the surface roughness of microhybrid composites. *Appl Oral Sci* 2009; 17(1): 21-26.
12. Patel SB, Gordan VV, Barrett AA, Shen C. The effect of surface finishing and storage solutions on the color stability of resin-based composites. *J Am Dent Assoc* 2004; 135(5): 587-594.
13. Fujýta M, Kawakamý S, Noda M, Sano H. Color change of newly developed aesthetic restorative material immersed in food simulating solutions. *Dent Mat J* 2006; 25(2): 352-359.
14. Topcu FT, Sahinkesen G, Yamanel K, Erdemir U, Oktay EA, Ersahan S. Influence of different drinks on the colour stability of dental resin composites. *Eur J Dent* 2009; 3(1): 50-56.
15. Ertap E, Güler AU, Yücel AC, Köprülü H, Güler E. Color stability of resin composites after immersion in different drinks. *Dent Mater J* 2006; 25(2): 371-376.
16. Poggio C, Dagna A, Chiesa M, Colombo M, Scribante A. Surface roughness of flowable resin composites eroded by acidic and alcoholic drinks. *J Conserv Dent* 2012; 15(2): 137-140.
17. Catelan A, Briso AL, Sundfeld RH, Dos Santos PH. Effect of artificial aging on the roughness and microhardness of sealed composites. *J Esthet Restor Dent* 2010; 22(5): 324-330.
18. Ardu S, Braut V, Gutemberg D, Krejci I, Dietschi D, Feilzer AJ. A long-term laboratory test on staining susceptibility of aesthetic composite resin materials. *Quintessence Int* 41(8): 695-702.
19. Mundim FM, Garcia Lda F, Pires-De-Souza Fde C. Effect of staining solutions and repolishing on color stability of direct composites. *J Appl Oral Sci* 2010; 18(3): 249-254.
20. Yalcin F, Korkmaz Y, Baþeren M. The effect of two different polishing techniques on microleakage of new composites in class v restorations. *J Contemp Dent Pract* 2006 1; 7(5): 18-25.
21. Attar N. The effect of finishing and polishing procedures on the surface roughness of composite resin materials. *J Contemp Dent Pract* 2007;8(1):27-23.
22. 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):118-124.
23. Yalcin F, Gürgan S. Bleaching induced colour change in plastic filling materials. *J Biomaterial Appl* 2005;9(3):187-195.

24. Aykent F, Yondem I, Ozyesil AG, Gunal SK, Avunduk MC, Ozkan S. Effect of different finishing techniques for restorative materials on surface roughness and bacterial adhesion. *J Prosthet Dent* 2010 ;103(4): 221-227.
25. Berger SB, Palialol AR, Cavalli V, Giannini M. Surface roughness and staining susceptibility of composite resins after finishing and polishing. *J Esthet Restor Dent* 2011;23(1):34-43.
26. Watanabe T, Miyazaki M, Takamizawa T, Kurokawa H, Rikuta A, Ando S. J Influence of polishing duration on surface roughness of resin composites. *Oral Sci* 2005;47(1):21-25.
27. Hegde MN, Hegde P, Bhandary S, Deepika K. An evaluation of compressive strength of newer nanocomposite: An in vitro study. *J Conserv Dent* 2011;14(1):36-39.
28. Pratten DH, Johnson GH. An evaluation of finishing instruments for an anterior and posterior composite. *J Prosthet Dent* 1988; 60(2):154-158.
29. Stoddard JW, Johnson GH. An evaluation of polishing agents for composite resins. *J Prosthet Dent* 1991;65:491-495.
30. Mohan M, Shey Z, Vaidyanathan J, Vaidyanathan TK, Munisamy S, Janal M. Color changes of restorative materials exposed in vitro to cola beverage. *Pediatr Dent* 2008 ;30(4):309-316.

ABOUT THE AUTHORS

Aslı Berber

Research Assistant, Department of Restorative Dentistry, Hacettepe University School of Dentistry, Ankara, Turkey

Filiz Yalcin Cakir (Corresponding Author)

Associate Professor, Department of Restorative Dentistry, Hacettepe University School of Dentistry, Ankara, Turkey, Phone: +90 312 3052270, Fax: +90 312 3104440, e-mail: fyalcin@hacettepe.edu.tr

Meserret Baseren

Professor, Department of Restorative Dentistry, Hacettepe University School of Dentistry, Ankara, Turkey

Sevil Gurgan

Professor, Department of Restorative Dentistry, Hacettepe University School of Dentistry, Ankara, Turkey