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Effect of finishing and polishing on color stability of a nanofilled resin immersed in different media

Efeito do acabamento e polimento na estabilidade de cor de uma resina composta nanoparticulada imersa em diferentes meios

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Resumo

Objetivo: O objetivo deste estudo foi avaliar o efeito do acabamento e polimento na estabilidade de cor da resina nanoparticulada Filtek Z350 XT em função de diferentes meios de imersão. **Material e método**: Espécimes circulares (10 mm de diâmetro e 2 mm de espessura) foram preparados para cada grupo (n=6) utilizando uma matriz de aço inoxidável. Os grupos experimentais foram divididos de acordo com a presença ou ausência de acabamento e polimento e diferentes meios de imersão (saliva artificial, Suco artificial pronto KAPO® da Coca-Cola® sabores: abacaxi, laranja, morango e uva). Os procedimentos de acabamento e polimento foram realizados com discos de lixa Super-Snap®. Os espécimes permaneceram em saliva artificial por 24 horas (*baseline*) e foram submetidos à análise da cor usando um espectrofotômetro pelo sistema CIELab. Em seguida, foram imersos nos diferentes meios por 5 minutos, 3 vezes ao dia, com intervalos de 4 horas, durante 60 dias. Os espécimes foram mantidos em saliva artificial a 37±1°C nos intervalos entre as imersões. Após este período foi realizada nova leitura de cor. Os dados foram analisados com os testes de Kruskall-Wallis e Mann-Whitney. O nível de significância foi de 5%. **Resultado**: Os resultados mostraram que o acabamento/polimento não influenciou significativamente a estabilidade de cor da resina composta (p>0,05). Não houve diferença estatisticamente significativa na estabilidade de cor da resina estudada após a imersão nos diferentes meios (p>0,05). **Conclusão**: O acabamento e polimento e os meios de imersão não apresentaram influência na estabilidade de cor da resina nanoparticulada Filtek Z350 XT.

Descritores: Resinas compostas; cor; polimento dental.

Abstract

Objective: The purpose of this study was to evaluate the effect of finishing and polishing on color stability of a nanofilled composite resin (Filtek Z350 XT) according to different immersion media. **Material and method:** Composite disks (10 mm diameter, 2 mm thickness) were prepared for each group (n = 6) using a stainless steel mold. The groups were divided according to the presence or absence of finishing and polishing procedure and immersion media (artificial saliva, artificial juice- KAPO® Coca-Cola® flavors: pineapple, orange, strawberry and grape). The finishing and polishing procedures were performed using Super -Snap® disks. The specimens were stored in artificial saliva for 24 hours (baseline) and were analyzed using a color spectrophotometer by CIELab system. Then, they were immersed in different media for 5 minutes, 3 times a day, every 4 hours during 60 days. They were stored in artificial saliva at 37 ± 1°C during the immersion intervals. After this time, new measure of color was performed. The data were analyzed using Kruskall-Wallis test and Mann- Whitney test. The significance level was 5%. **Result**: The results showed that the finishing/polishing not significantly influence the color stability of resin composite (p > 0.05). There was no statistically significant difference in the color stability of the studied resin after immersion in different media (p > 0.05). **Conclusion:** The finishing and polishing procedures and the immersion media did not have influence on color stability of nanofilled resin Filtek Z350 XT.

Descriptors: Composite resins; color; dental polishing.

INTRODUCTION

Among the direct restorative materials, composite resin is considered the material of choice whenever esthetic appearance is a concern[1]. However, when this material is present in the oral environment, it becomes vulnerable to the influence of some factors that may result in staining[2-8].

Surface staining is a process that deserves attention since it leads to the esthetic failure of restoration and is considered one of the most frequent causes of limitation on their longevity[9].

This process, which is due to a change in color stability of the composite, has a multifactorial etiology,[10-13] involving intrinsic[10,14] and extrinsic factors[6,14-16].

The intrinsic factors include the characteristics of the restorative material, such as type of organic matrix, inorganic load particle size and percentage of the composition, and degree of conversion[10,12,16,17].

With regard to the influence of extrinsic factors on color stability, factors related to patient behavior, such as poor oral hygiene and diet based on foods and beverages containing pigments; and those related to the dentist such as finishing and polishing procedures are highlighted[10,13,15,17].

The finishing and polishing procedures should be considered, given that rough tooth surfaces may contribute to the deposition of dental plaque and residues[18]. This deposition can cause gingival irritation, risk of secondary caries and decrease the brightness of the restoration, making it possible for discoloration and/or surface degradation to occur[19-22].

The intake of pigmentation agents present in beverages such as tea, coffee, soda, juice and wine are also capable of promoting restoration staining[2-8] in materials with a higher rate of water sorption, because they tend to absorb more pigments since water can transport the dye into the material causing more intense staining[23].

In this context, whereas the consumption of artificial juices sold in single-dose packs has increased considerably among the pediatric population, it becomes important to see whether these alter the optical properties of the composite.

Thus, the aim of the present study was to observe the effect of finishing and polishing on color stability of composite resin, considering its immersion in artificial juices with different flavors.

MATERIAL AND METHOD

This research was a double-blind experimental study. The dependent variable was the color stability of a nanofilled composite resin (Filtek Z350 XT – 3M/ESPE, St Paul, MN, USA). The independent variables were finishing and polishing procedures in two levels (With and Without) and immersion media in five levels (artificial saliva, artificial juice- KAPO® Coca-Cola® flavors: pineapple, orange, strawberry and grape). The association between the variables resulted in ten groups (n=6).

The specimens were made using a two-piece stainless steel matrix with four circular holes measuring 10 mm in diameter and 2 mm thick[24]. The composite resin was inserted into the matrix in a single increment, over which a polyester strip (K-Dent – Quimidrol, Joinville, SC, Brazil) and a glass plate were placed. A 1kg stainless steel weight was applied for 30 seconds to drain the excess and leave the surface smooth and standardized[25]. The weight and glass plate were removed and specimens were light-polymerized for 40 seconds, using the Halogen Curing Light XL 3000 (3M Dental Products Division, St. Paul, MN, USA). The irradiance (530mW/cm^2) was constantly monitored by a radiometer (Curing Radiometer Model 100, Demetron Research Corp., Danbury, CT, USA).

Half of the sample was subjected to finishing/polishing procedures with Super-Snap® aluminum oxide discs (Shofu Dental Corp. Kyoto, Japan), 12 mm in diameter, in a sequence of decreasing granulation. Each disk was used on the dampened surface for 15 seconds[26]. The specimens were placed in a two-piece stainless steel matrix with height adjustment,[14] which prevented any contact of the finishing and polishing instruments with the matrix surface. These procedures were performed perpendicular to the bipartition marking,[13] with a standardized pressure of 2 kg.

Between one disc and another, the samples were washed with air-water jets for 5 seconds. At the end of the process, an ultrasound appliance (Ultrasonic Cleaner Plus 1440, Odontobrás - Doctors Trade in Eq - Dental Ltd., Ribeirão Preto, Sao Paulo, Brazil) containing water was used for 30 minutes, to remove possible debris deposited on the surface.

The samples were immersed in artificial saliva and stored in a Bacteriological oven (EBC1-Odontobras - Comércio de Eq. Médicos-Odontológicos LTDA, Ribeirão Preto, SP, Brazil), and maintained at a temperature of 37 ± 1°C for 24 hours.

After 24 hours in artificial saliva, the specimens were immersed in different immersion media (experimental groups) for 5 minutes, three times per day, with intervals of 4 hours. After immersion, the specimens were rinsed in distilled water, and kept in artificial saliva. For the control group, similar conditions to those of the experimental groups were simulated, using artificial saliva. This procedure was repeated daily for a period of 60 days.

The color-change readouts were made by a properly calibrated tracer (ρ_L= 0.90; ρ_a= 0.75; ρ_b= 0.95). A Colorimetry Spectrophotometer was used (Color guide 45/0, PCB 6807 BYK-Gardner GmbH Gerestsried Germany), with direct transmission, standard lighting D65 against a white background[16,26,27]. The spectrophotometer used had a wavelength ranging from 400nm to 700nm.

In this study, two color readouts were made in each test specimen, one before immersion in the solutions began (baseline - 24 hours after immersion in artificial saliva) and the other after 60 days of immersion in the solutions.

The color change value (ΔE*) was calculated according to the following formula:[28] $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$

The influence of finishing/ polishing of composite resin Filtek Z350 XT and immersion media on color stability was tested considering the color change (ΔE) after 60 days of immersion. The assumptions of normality and homoscedasticity were not met.

The Kruskal-Wallis test was used to compare the color change of the composite resin considering the different immersion media. The Mann-Whitney test was used to compare the color change of the specimens according to finishing and polishing procedure. The significance level used was 5%.

RESULT

The results about the color change (ΔE) of Filtek Z350 XT resin after 60 days of immersion in different media are shown in Table 1.

No statistically significant difference was detected between groups (Kruskal-Wallis and Mann-Whitney, $p > 0.05$).

The analysis of the results showed that the finishing / polishing does not have significant influence on the color stability of composite resin, considering the same immersion media (artificial saliva $p= 0.200$; Strawberry $p = 0.575$; Grape $p = 0.109$; orange $p = 0.055$; Pineapple $p = 1.000$).

Both in the evaluation of color stability of specimens with and without finishing and polishing, there was no statistically significant difference when considering the different immersion media (with finishing/polishing $p = 0.232$; without finishing/ polishing $p = 0.589$).

DISCUSSION

Staining is a major cause of esthetic restorations replacement,[9,29] therefore, the factors affecting the color stability of these restorations should be extensively studied. In this study we evaluated the influence of finishing and polishing with aluminum oxide discs on the color stability of a nanofilled resin (Filtek Z350 XT) immersed in different flavors of artificial juices. It was found that the groups with finishing/ polishing procedures had color change values that were not statistically significant when compared to groups without finishing and polishing ($p > 0.05$).

Similar results to those of the present study were also found by Bagheri et al.[16] and Nagem Filho et al.[20]

The polyester strips used in the preparation of specimens of both groups (with and without finishing/polishing) allowed a greater surface smoothness, thus decreasing the roughness of the resin and consequently the possibility of staining. According to Patel et al.[12] when the resins are polymerized in air, the polymerization of the surface layer is inhibited by oxygen. Thus, the use of polyester strip promotes greater surface smoothness in addition to preventing contact of the material with air, and therefore eliminates the layer of unpolymerized resin. On the other hand, according to Dietschi et al.[23] and Rueggeberg, Margeson[30], the area under the polyester strip appears to have a lower degree of polymerization than the rest of the restoration. Theoretically, this could increase restoration susceptibility to staining. In this situation, the finishing and polishing procedure could contribute to the color stability because it removes this surface resin matrix. However, the removal of the surface layer of the resin by finishing/ polishing did not affect the color stability, because in the present study the composite resin used has a matrix with hydrophobic features[31] (small amount of TEGDMA associated with BisEMA).

Pereira et al.[18] and Rai, Gupta[32] found that the polyester strip promoted greater surface smoothness. However, according to Pereira et al.[18], there are some situations in which it is necessary to remove the excess restorative material and in this case, finishing and polishing is indicated. If this occurs with nanofilled resin, the finishing and polishing will not interfere in the smooth surface and color change, and can therefore be more safety used, as regards color stability.

Another factor considered in this study was the immersion medium, which did not influence the color stability of the studied composite. Several studies[2-8] in the literature have shown that foods and beverages present in patients' diet, especially those containing alcohol,[33] sugar[3,26] and acid[12,16] in their composition, can promote change in the color of esthetic restorative materials. The KAPO® juice used in this study, irrespective of the flavor tested, has citric acid and sugar in its composition, but possibly in insufficient amount to promote color change.

Note also that the color change values (ΔE) observed in Filtek Z350XT, irrespective of immersion media and finishing and polishing, were lower than 3.7. According to Guler et al.[26] and Setembrini et al,[25] these values correspond to color change that is not clinically perceptible. According to Saito et al.[34], the characteristics of the restorative material are determinant factors in their pigmentation. Bispo[35] noted that the surface smoothness was improved by the structural characteristics of tiny particles of inorganic filler of the nanofilled composite studied. Since the resin used for this study was a nanofilled, this characteristic may have positively influenced the color stability.

Table 1. Color change (ΔE) of Filtek Z350 XT resin according to the immersion media and finishing and polishing procedures (Median, Percentile 25 and Percentile 75)

Immersion Media	Finishing and Polishing	
	With	Without
Artificial saliva	1.17 (0.53-1.54)	1.53 (1.12-2.25)
Strawberry juice	1.86 (1.15-3.37)	1.88 (1.61-3.73)
Grape juice	0.87 (0.41-2.07)	1.29 (1.14-2.62)
Orange juice	1.13 (0.70-1.75)	2.49 (1.16-3.83)
Pineapple juice	1.56 (1.09-3.67)	2.36 (0.75-3.31)

CONCLUSION

The Filtek Z350 XT resin showed good color stability when immersed in different flavors of juices for 60 days, irrespective of finishing and polishing procedures.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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