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Surface roughness of a resin composite

Rugosidade superficial de resina composta

Carlos Alberto Camargo ISABEL[1]
Alexandre Augusto Sarto DOMINGUETTE[1]
Saulo Galvão dos SANTOS[2]
José Carlos Rabelo RIBEIRO[1]
Marcos Ribeiro MOYSÉS[1]

ABSTRACT

Objective
The aim of the present study was to evaluate the surface roughness (Ra) of the Z-350 resin composite following immersion in different media (distilled water, coca-cola, coffee, black tea and red wine).

Methods
Fifty specimens of resin composite measuring 10 mm x 2 mm were prepared. Polymerization was performed using the conventional method (40 s). Each specimen was immersed for one hour per day. Evaluations were performed at baseline as well as after three, six, nine and 12 months. Three Ra readings were taken in opposite directions at each evaluation using a roughness meter. Mean Ra values were subjected to analysis of variance (ANOVA) followed by Tukey's test ($p < 0.05$).

Results
A significant increase in Ra was found in the specimens submitted to coffee, coca-cola® and black tea between baseline and the three-month evaluation. Variance was also found among the remaining evaluation times (3 months to 12 months), but the differences did not achieve statistical significance. No statistically significant differences in Ra were found among evaluation times in the specimens submitted to red wine or distilled water.

Conclusion
Based on the present findings, coca-cola, coffee and black tea exert an influence on the surface roughness of resin composites.

Indexing terms: *Beverages. Immersion. Resin composite. Tooth erosion.*

RESUMO

Objetivo
Avaliar a rugosidade da superfície (Ra) do Z-350 resina composta após imersão em diferentes meios (água destilada, coca-cola, café, chá preto e vinho tinto).

Métodos
Foram preparados cinquenta espécimes de resina composta medindo 10 mm x 2 mm. A polimerização foi realizada através do método convencional (40 s). Cada espécime foi imerso durante uma hora por dia. As avaliações foram realizadas na linha de base, bem como após três, seis, nove e 12 meses. Três leituras Ra foram levados em direções opostas em cada avaliação, utilizando um medidor de rugosidade. Os valores médios de Ra foram submetidos a análise de variância (ANOVA) seguido pelo teste de Tukey ($p <0,05$).

Resultados
Um aumento significativo na Ra foi encontrada nas amostras submetidas ao café, coca-Cola® e chá preto entre o início e a avaliação de três meses. Variância também foi encontrado entre as épocas de avaliação restantes (3 meses a 12 meses), mas as diferenças não atingiram significância estatística. Não houve diferenças estatisticamente significativas na Ra encontrados entre os momentos de avaliação nos casos submetidos ao vinho tinto ou água destilada.

Conclusão
Com base nos achados, coca-cola, café e chá preto exercem uma influência sobre a rugosidade superficial de resinas compostas.

Termos de indexação: Bebidas. Imersão. Resinas compostas. Erosão dentária.

[1] Universidade do Vale do Rio Verde, *Campus* Três Corações, Departamento de Odontologia. Av. Castelo Branco, 82, Chácara das Rosas, 37410-000, Três Corações, MG, Brasil. Correspondência para / *Correspondence to*: MR MOYSÉS. *E-mail*: <marcos.ribeiro.moise@terra.com.br>.
[2] Universidade Estadual Paulista Júlio de Mesquita Filho, Faculdade de Odontologia. Araraquara, SP, Brasil.

INTRODUCTION

The durability of restorative materials in the oral cavity is related to their resistance to dissolution and disintegration[1-4]. Resin composites are frequently subjected to harm in the oral cavity in the form of abrasion (brushing), attrition (diet and parafunctional habits) and erosion (citrus drinks, fruit, soft drinks)[5-7].

The erosive activity of beverages affects the composite restorations, leaving a rough surface that influences the optical properties of the material[8-9], and facilitates the buildup of bacterial plaque and degradation of the surface of the restoration[10-11]. Erosion leads to a reduction in hardness and wear resistance[1-4]. Moreover, surface roughness can cause gingival irritation and increases the risk of secondary caries[8,10]. Thus, the surface characteristics of a resin composite contribute to the clinical longevity of a restoration[12].

Although a number of studies have addressed the effects of different solutions on the surface of resin composites[13-15], few have performed long-term evaluations. Thus, the aim of the present study was to evaluate the surface roughness (Ra) of a resin composite submitted to immersion in different beverages one hour per day for three, six, nine and 12 months.

METHODS

Fifty specimens were prepared with the Z-350® resin composite (3M ESPE, Saint Paul, USA) their technical specifications are displayed in Table 1. Each specimen measured 10 mm x 2 mm. After inserting the material, a strip of polyester (Fava, Pirituba, Brazil) was placed over the matrix and the tip of the curing light was pressed against the assembly to form a flat surface on the specimens. Polymerization was performed using the conventional method (Elipar Free Light II / 3M Espe, Seefeld, Germany, 1200 mW/cm^2 for 40s). The specimens were submitted to immersion in different media distilled water (Asfer, São Caetano do Sul, Brazil), coca-cola® (Coca-Cola®, Petrópolis, Brazil), coffee (Três Corações, Santa Luzia, Brazil), black tea (Moinhos Unidos, Curitiba, Brazil) and red wine (Canção, Flores da Cunha, Brazil), for one hour per day and their technical specifications are displayed in Table 2. The specimens were subsequently washed and returned to their recipients with distilled water at 37 ± 1 °C for 23 hours.

At predetermined times [baseline (T1), 3 months (T2), 6 months (T3), 9 months (T4) and 12 months (T5)], three Ra readings were taken in opposite directions using a roughness meter (Surftest SJ-301 Mitutoyo, Kanagawa, Japan). Statistical analysis was performed using Statistical Package for Social Sciences (SPSS for Windows, version 18.0, SPSS Inc, Chicago, USA), mean Ra values were subjected to analysis of variance (ANOVA) followed by Tukey's test ($p < 0.05$).

Table 1. Resin composite.

Material	Particles	Particle size	Bulk (% weight)	Matrix
Filtek Z350	Nonparticle silica (not agglomerated/ not aggregated) and nanoclusters of zirconia/ silica	Nanoparticles of silica 20 nm Zirconia/silica: 5-20 nm nanoclusters: 0.6 to 1.4 µm	78.5 %	Bis-Gma, Bis-Ema, UDMA and TEGDMA

Table 2. Study groups.

Material	Particles	Matrix
Distilled water	5.5	
Coca-Cola	2.7	Carbonated water, sugar, kola nut extract, caffeine, caramel coloring IV, INS 338 acidifier and natural aroma
Coffee	5.01	Caffeine, theobromine, caffeic acid, theophylline, vanillic acid, benzoic acid
Black tea	5.8	Leaves and buds of black tea (*Camelia sinensis*).
Red wine	3.7	Water, sugar, ethyl alcohol, grape juice, tartaric acid; alcohol content: 10.4%

RESULTS

Figure 1 displays the mean Ra and standard deviation values. A significant increase in Ra was found in the specimens submitted to coffee, coca-cola® and black tea between baseline and the three-month evaluation. Variance was also found among the remaining evaluation times (3 months to 12 months), but the differences did not achieve statistical significance. No statistically significant differences in Ra were found among evaluation times in the specimens submitted to red wine or distilled water.

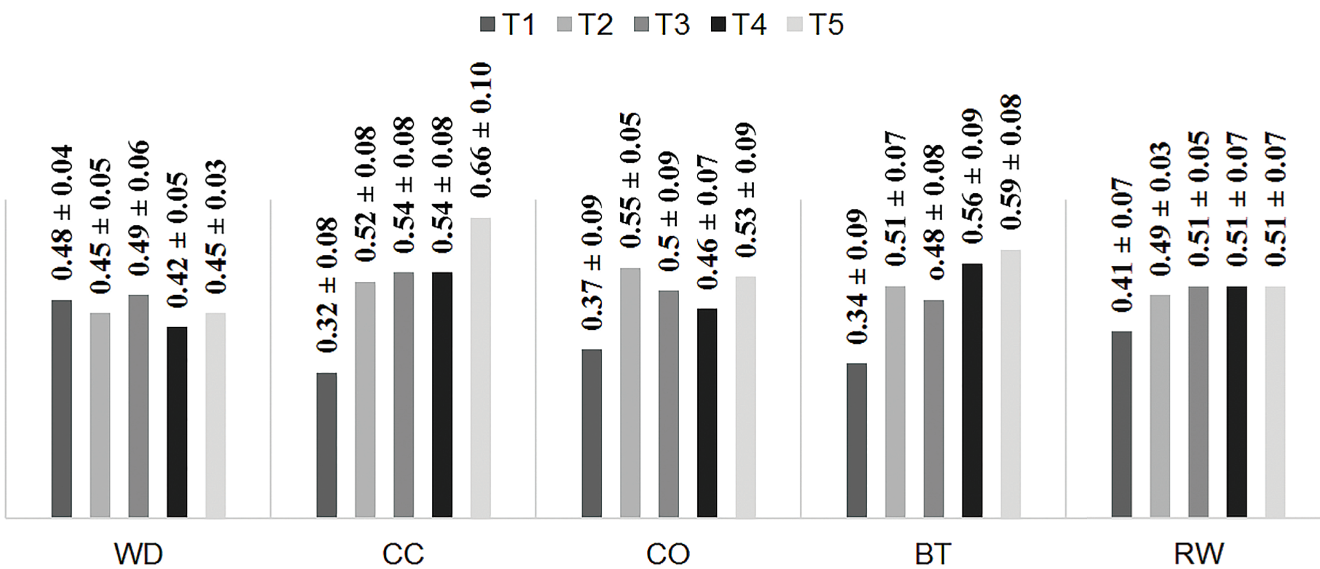

Figure 1. Average of roughness and e de standards dos groups avalied.
Note: Mean Ra values were subjected to analysis of variance (ANOVA) followed by Tukey's test ($p < 0.05$).

DISCUSSION

It is important to maintain a smooth surface on dental restorations to avoid problems such as changes in color and brightness and minimize the risk of secondary caries[9,11]. A rough surface facilitates the buildup of bacterial plaque and can affect periodontal health[16]. It is therefore ideal to make the surface of a composite resin as smooth as possible to obtain optimum clinical performance. However, the frequent ingestion certain substances can lead to an increase in surface roughness, as demonstrated in the present investigation.

A number of studies have evaluated the effect of different beverages on the surface of resin composites[13,15,17-19], but few have performed long-term evaluations, likely due to the difficulties such as daily changes of the immersion media.

In the present study, no statistically significant differences among evaluation times were found for the samples submitted to red wine, despite the low pH (3.7) and alcohol content (10.4%) of this medium. Alcohol is a great solvent of polymer chains and high concentrations of this substance (50 to 75%) soften the surface of a resin composite, leading to increased roughness[1,20-24]. The lack of a significant difference in this group was likely due to the low concentration of alcohol in red wine.

The significant difference found in the specimens submitted to coca-cola® (pH 2.7) was likely due to the phosphoric acid and sugars in the chemical composition of this beverage, causing erosion to the surface of the resin composite[17,19]. Significant differences in Ra were also found in the specimens submitted to coffee and black tea beginning at three months. While the respective pH values are 5.0 and 5.8, the composition of these beverages may have been the cause of erosion, as these natural substances have different long-chain organic acids[18] that can dissolve and erode restorative materials[17-18,25].

Differences in pH did not influence the results as much as the presence of acids in the substances evaluated. Indeed, a more acidic pH does not appear indicate greater erosive potential[26]. Erosion depends on the combined effect of physicochemical properties, total amount of acid, mineral content and titratable acidity[26-27].

Further investigations should be performed addressing the frequency of intake as well as the physicochemical characteristics of these beverages, which can influence changes in the surface roughness of resin composites. Although the present in vitro findings do not allow the prediction of clinical performance, the data serve as a warning to dentists regarding problems involving rough surfaces on resin composites, which can be caused by different beverages.

CONCLUSION

Based on the present findings, coca-cola®, coffee and black tea exert an influence on the surface roughness of resin composites.

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Collaborators

CAC ISABEL test runner in rugosimeter, exchanges of immersion media, and wording of article. AAS DOMINGUETTE it was responsible for handling test bodies and wording of article. SG SANTOS e JCR RIBEIRO they were responsible for statistical analysis and writing of the article. MR MOYSÉS he supervised the research and participated in the writing of the article.

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