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Original Article

Dentistry Section

Influence of Cola-Based Soft Drinks on the Microhardness of Nanohybrid and Bulk Fill Composites

LUIS HENRIQUE BRUGIM[1], JAISSON CENCI[2], PRISCILLA DO MONTE RIBEIRO BUSATO[3], MAURO CARLOS AGNER BUSATO[4], VERIDIANA CAMILOTTI[5], MARCIO JOSÉ MENDONÇA[6]

ABSTRACT

Introduction: Bulk fill composites have been introduced in the past few years and appear to solve some of the disadvantages of conventional composites such as polymerisation contraction and the consequent marginal microinfiltration.

Aim: To evaluate the surface microhardness of the Z350 and the Bulk fill composites when immersed in distilled water, for 24 hours, and immersed in Coca-Cola™, along with distilled water, for 30 days.

Materials and Methods: Seventy two specimens from each composite were evaluated, being divided into two groups and kept in distilled water at 37°C, for 24 hours and, subsequently, submitted to the Knoop microhardness analysis. After performing the reading, 12 specimens from each composite were individually stored in distilled water and in Coca-Cola Classic™ at 37°C, for 30 days and, then, the Knoop Hardness Number (KHN) value analysis was performed again. Data were submitted to the statistical analysis applying the Kruskal-Wallis test and the Dunn's post-test ($p<0.05$).

Results: Immersion after 30 days in Coca-Cola™ and distilled water similarly changed KHN values for Z350 and Bulk Fill composites. The analysis between the composites showed statistically significant changes for the group immersed in distilled water, in 24 hours, as well as for the group immersed in Coca-Cola™, with higher KHN for the Z350 composite (57.69±4.15), ($p<0.0001$).

Conclusion: The bulk fill composite presented lower microhardness values than the Z350 composite after immersion in distilled water, for 24 hours, and immersion in Coca-Cola™. However, the immersion in distilled water, for 30 days, did not show differences between the two evaluated composites.

Keywords: Acid solution, Dental erosion, Resin

INTRODUCTION

The search for dental aesthetics and harmonic restorative procedures, favouring the reproduction of the natural characteristics of the teeth, along with the restoration of the dental function, promoted scientific and technological progress aiming at developing new techniques and materials to attend this demand. Thus, the indication to use composites to restore anterior and posterior teeth has increased substantially in the recent decades, due to changes in its composition and the simplification in the bonding technique to the dental tissues [1-3]. In addition, the composites present aesthetic quality that makes the patient to expect restorations with colours similar to the tooth [3,4]. To emphasise the advantages of these materials and to increase the clinical life cycle of restorations, it is necessary to use adequate light-curing protocols [5].

In addition to light-curing devices with advanced technology, the composite polymerisation shrinkage and the stress caused by fast shrinkage is still a concern to dental surgeons. Thus, light curing techniques have been developed, including from light intensity to shape and amount of composite that should be used in an aesthetic restoration. Thus, single-increment composites, the so-called Bulk-fill composites, have been indicated for use in aesthetic restorations of posterior teeth in class I and II cavities [6,7]. However, there are few studies reporting on the mechanical and the physical properties of these new materials when compared to conventional composites that apply the incremental technique [8,9].

The microhardness of a composite is affected by not only the level of conversion [3], but, also, by the charging particles from the restorative material [1-3], as well as by the storage conditions and the occurrence, or not, of uncured surface layers established by the presence of oxygen. Thus, the application of hardness tests (Vickers or Knoop) contributes to the evaluation of the mechanical properties of the resinous material, in which the results achieved after the application of these tests enable the analysis of the conversion level of a composite, as well as its hardness. Thus, the use of hardness tests (Vickers or Knoop) contributes to the evaluation of the mechanical properties of the resinous material and the results achieved after the application of these tests makes it possible to analyse of the level of conversion of a composite, as well as its hardness [10].

With the reduction of microhardness and/or alteration of the surface roughness of the composite, some failures may occur due to bacterial colonisation and poor hygiene, leading to restoration failure [1]. Hardness is a mechanical property that expresses the wear resistance of the composite [1,2,11,12].

Therefore, the current research study aims at evaluating the surface microhardness of the Z350 and the Bulk fill composites when immersed in distilled water, for 24 hours, and immersed in Coca-Cola™, along with distilled water, for 30 days.

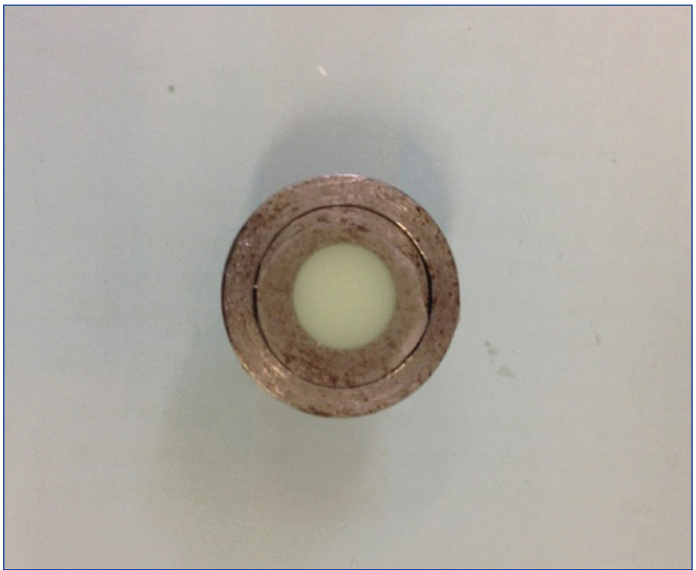
MATERIALS AND METHODS

This experimental, *in-vitro* study was conducted between March and December 2015 in Cascavel Campus of State University of Western Paraná (UNIOESTE), Paraná, Brazil and lasted four weeks. The evaluation by the Human Ethics Committee was not necessary because it was a laboratory study, using only dental material, without human involvement. The sample was calculated using a family F probability, with a repeated families design, with interaction within and among the factors. The effect size of 0.15, type 1(α) error of 0.05, and analysis power of 0.85 chosen resulted in 72 sample units, with 12 samples per experimental group (n=12). G Power software (version 3.1.9.2, University of Düsseldorf, Germany) was used for sample calculation.

For the accomplishment of this study, 72 specimens from each composite were divided in two groups of 36 specimens each [Table/Fig-1]. The specimens were prepared in a cylindrical steel die with a central hole of 2 mm in height and 5 mm in diameter [13]. The composites were inserted into the cylindrical steel die, in resting position, on a glass plate, and filled with a single increment. After filling the die, a polyester strip (Probem Ltda, Catanduva, São Paulo, Brazil) was placed on it, and, over it, a 2 mm thick glass plate, pressed for 10 seconds for surface smoothness. The glass plate was then removed, from the surface, and light-cured with the nozzle in direct contact with the polyester strip, using a Blue Phase (Ivoclar-Vivadent) Barueri, São Paulo, Brazil, LED light-curing device, with irradiance 1200 mW/cm^2, for 20 seconds, according to the manufacturer's instructions [Table/Fig-2].

Commercial brand	Manufacturer	Quantity of charge particles	Composition	Lot number
Nanoparticle composite Z350 XT	3M (ESPE)	63.3 in volume and 78.5 by weight	BIS-GMA, UDMA, TEGDMA, PEGDMA, BIS-EMA, Zirconia, silica, zirconia/silica aggregated	1425400839
Filtek bulk fill	3M (ESPE)	58.4in volume and 76.5 3 by weight	Silica, zirconia, ytterbium trifluoride	1522200101

[Table/Fig-1]: Materials used in the study with composition and lot number.

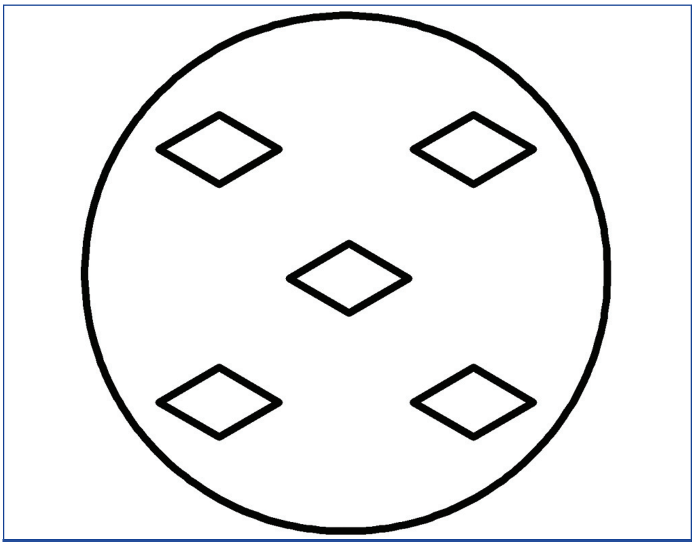


[Table/Fig-2]: Preparation of test specimens.

The specimens were kept in an oven with distilled water at 37°C, for 24 hours, and, then, fixed in wax utility and submitted to the penetration test for the Knoop microhardness analysis of their top surfaces. The microhardness measurements were taken using the FM 800 micrometre (Future Tech), under 50-gram loading, for 15 seconds. Five indentations [Table/Fig-3] were made on the top surface of each test specimen and an average value was obtained [1,2,14-16], The average was determined as KHN.

After reading 12 specimens from each evaluated composite, the same quantity of additional samples was stored individually in the following solutions at 37°C, for 30 days: 1- Distilled water; 2- Coca-Cola Classic™. The solutions were changed every four days because in our pilot test the pH of the solutions did not change after this period [Table/Fig-4].

The pilot test was performed in order to make the decision on the change interval between the solutions more certain, since the literature on the subject is not homogeneous, as there is a large variation in the change interval of the food simulants solutions [17,18], and in this work, based on the results of the Coca-Cola Classic™ pH change pilot test, the solution was changed every four days.



[Table/Fig-3]: Schematic drawing of the indentations made on the specimen surface.

Days	1	2	3	4
pH	2.73	2.65	2.61	2.61

[Table/Fig-4]: Cola-based soft drink pH for four days.

The solution pH values were determined through a pilot study [Table/Fig-4]. The solutions' composition is shown in [Table/Fig-5].

Solution	pH	Composition	Commercial brand
Distilled water	6.30	Distilled water	
Cola-based soft drink	2.73	Carbonated water, sugar: 2400g, enough water to dissolve: caramel 37g; caffeine 3.1g; phosphoric acid 11g; decocainized coca leaf: 1.1g; Kola nut 0.37g.	Coca-Cola Classic™/ Coca-Cola Company

[Table/Fig-5]: Description of the solutions used with the pH value.

After 30 days, the specimens were removed, using Potts Smith Tweezer with 18 cm Widia (Quinelato), washed in running water and dried with absorbent paper towels and stirred in the air for a few seconds. Then, the surface microhardness values were measured on the top of the specimens.

STATISTICAL ANALYSIS

The data were submitted to statistical analysis using Bioestat 5.3 software (Mamirauá Institute, AM, Brazil, 2007). Initially, the data were submitted to the Shapiro-Wilk test to verify the normality curve. As the data were not considered normal, so they were submitted to the Kruskal-Wallis test and, later, to the Dunn's post-test ($p<0.05$).

RESULTS

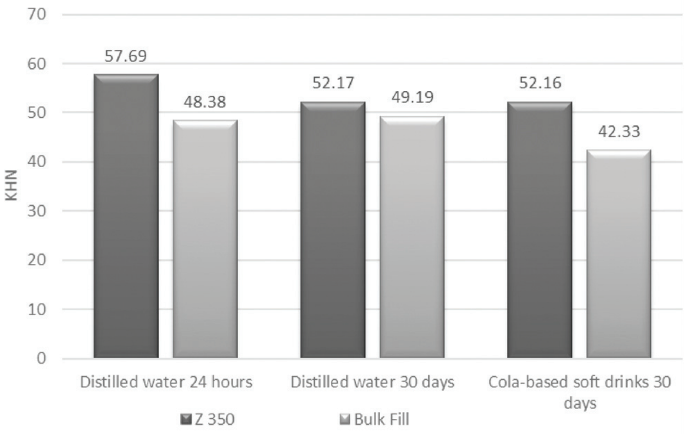
The analysis comparing the different solutions for the same composite has presented, for the Z350 composite, higher surface microhardness values for the group immersed in distilled water, for 24 hours, when compared to the groups immersed in distilled water, for 30 days, and in the cola-based soft drink, for 30 days ($p=0.009$). The analysis for the Bulk Fill composite has shown that the immersion in distilled water, for 30 days, presented statistically similar values than the other groups. Furthermore, the comparison between the groups immersed in distilled water, for 24 hours, and in cola-based soft drink, for 30 days, has presented lower values for the group immersed in cola-based soft drink, for 30 days ($p=0.002$) [Table/Fig-6].

The analysis on the influence of the evaluated solutions on the composites has shown that the Z350 composite presented the highest microhardness values when immersed in distilled water solution, for 24 hours ($p=0.004$), and in cola-based soft drink, for 30 days ($p=0.004$). The comparison between the composites

Solutions/ Composites	Distilled water 24 hours		Distilled water 30 days		Cola-based soft drinks 30 days	
Z350	57.69	(+4.15)a	52.17	(+5.02)a	52.16	(+4.91)b
Bulk fill	48.38	(+2.94)a	49.19	(+2.62)a	42.33	(+5.03)a

[Table/Fig-6]: Median values followed by the respective interquartile deviation of Knoop Hardness Number (KHN), for the experimental groups.
Different letters (a, b) within the same line indicate a significant difference between the immersion solutions (p<0.05)

immersed in distilled water, for 30 days, has shown no statistically significant differences between the composites (p=0.1060), [Table/Fig-7].



[Table/Fig-7]: Chart showing the mean values of Knoop Hardness Number (KHN) in the experimental groups.
*Statistically significant differences between the evaluated composites for the same evaluated solution, p<0.05

DISCUSSION

In recent years, restorative materials have progressed a lot considering their mechanical, physical and, mainly, their optical properties, being applied in a range of routine clinical situations. Despite having all these properties, there are gaps and barriers, in which the main factor is colour change [4,5,16,19,20].

Studies have shown that tooth erosion is influenced by acidic food and beverages such as soft drinks, orange juice and cola-based beverages [1,2,12,21,22]. Sadat HS et al., tested the effects of 100% orange juice and non-alcoholic carbonated beer on microhardness of a silorane-based composite in comparison with two methacrylate-based composite resins, and concluded that 28 days of immersion in these solutions decreased the microhardness of all the specimens [21]. Xavier AM et al., evaluated the surface microhardness changes of aesthetic restorative materials following treatment with cola-based beverages and concluded that the surface microhardness of restorative materials markedly reduced upon repeated exposures with these acidic beverages [12].

Erosion is defined as the local, chronic, pathological and painless loss of the tooth structure through a chemical process of acid dissolution, without bacterial involvement [3,23,24]. The acidity can be indicated by the pH value and several studies suggest that beverages and acidic food have low pH values [1,2,15,16,21].

The results of the research agree with the authors who reported that the reduction of hardness, after immersion in chemical substances, may be responsible for changes in aesthetic restorative materials, including food or food simulants [20] and soft drinks [1,3,16,23,24].

Coca-Cola™ (pH 2.3) was included in this study due to its erosive potential and, also, because it is widely consumed worldwide [3,15,19,24]. This substance may cause different effects on the surface of composites such as: increase in roughness [3,25-27], reduction of microhardness [1,3,12,16,24]; colour change and translucency alterations [4,5,27-29], in addition to morphological changes [25]. Furthermore, Coca-Cola™ is a carbonate beverage containing carbonic acid and phosphoric acid which promotes dissolution and easily eroded the materials [30].

In the current research study, the evaluated composites showed a reduction in the average values of the surface microhardness, in which the Bulk fill composite presented the microhardness values statistically lower than the Z350 composite after immersion in distilled water at 37° C, for 24 hours, and immersion in Coca-Cola™, for 30 days. Poggio C et al., also showed that the acidic pH of beverages associated with the progressive immersion time significantly change the surface microhardness of the composites, with a fact being that nanoparticulate composite presented higher microhardness values [1].

This microhardness decrease can be related to chemical and mechanical alterations such as the solvent sorption of the composite, or the presence of porosity and surface erosion [3].

The results of the study showed superiority in the microhardness values of the Z350 composite when compared to the Bulk fill, even after immersed in various solutions for 30 days.

LIMITATION

Although laboratory tests are a major analysis parameter but they cannot accurately reproduce clinical conditions. But, when extrapolating the results of the present study for the in vivo condition, it should be considered that for composite Z350 could show superiority when compared to the Bulk fill, after immersed in cola base soft drink for 30 days.

CONCLUSION

The Bulk fill composite presented lower microhardness values than the Z350 composite after immersion in distilled water solution, for 24 hours, and in cola-based soft drink. The immersion in distilled water, for 30 days, did not show difference for the two evaluated composites.

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PARTICULARS OF CONTRIBUTORS:

1. Student, Department of Dental Materials, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.
2. Student, Department of Dental Materials, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.
3. Associate Professor, Department of Restorative Dentistry, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.
4. Associate Professor, Department of Dental Materials, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.
5. Associate Professor, Department of Restorative Dentistry, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.
6. Associate Professor, Department of Prosthodontics, Western State University of Paraná-Dental School, Cascavel, Paraná, Brazil.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Jaisson Cenci,
Rua Universitária, 2069-Faculdade, Cascavel, Paraná, Brazil.
E-mail: jaissoncenci@yahoo.com.br

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