Research Article

Effect of mouthwashes on different composite resin – An *in vitro* study

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ABSTRACT

Aim: The aim of the study was to evaluate the effect of mouthwashes on the different composite resins. **Materials and Methods:** Fifteen cylindrical specimens were prepared for each of the composite (micro hybrid composite, nano hybrid composite, and fine hybrid composite). The baseline weight of each composite was determined. These composites were dispensed into the mouthwashes (mouthwash containing alcohol and mouthwash not containing alcohol), respectively. The weight of the composites was weighed after 24 h and after 48 h. The mean values of the weight were calculated. Data were analyzed using one-way ANOVA and *post hoc* Tukey's test. **Results:** Listerine cool mint (containing alcohol in its composition) caused the greatest degree of sorption in nano hybrid composite resin. It was found that among the different composite resin, fine hybrid composite showed to be the most stable and more superior than the other composites. **Conclusion:** Overall sorption of the composites was higher in mouthwashes containing alcohol.

KEY WORDS: Alcohol, Composite resin, Mouthwashes, Sorption, Weight

INTRODUCTION

In clinical dentistry, restorative composites have been used widely for their esthetic quality and adhesion ability to dental structures. Restorative composites have been indicated and used for anterior and posterior teeth.[1] This is mainly due to the improvements in the mechanical property of restorative composites. Resin composites are made up of a polymeric matrix, filler particles, and silane-coupling agent that links the matrix to fillers.[2,3] Resin composite is a polymer-based material; thus, it may suffer degradation when it is applied in the oral cavity.[4] The degradation of resin composites is a complex mechanism that involves water sorption inside the material and other-related phenomena, such as thermal and mechanical cycling, crack propagation, and attenuation. These phenomena are mainly dependent on the composition of the polymeric matrix and features of its filler particle system.[5-7]

Previously, the restoration for choice for posterior teeth was mercury-containing silver amalgam restoration, but now it was substituted with resin composite. This is because resin composite is mercury-free and less expensive than cast metal. The longevity of resin composite is still controversial because it many variables in the oral environment. The main difference between composite and metallic restorations is that composites are water sorptivity, whereas metallic ones are not water sensitive. The resin may swell and contract thereby contributing to the possible failure of the restoration.[8] As mentioned, resin composite is able to absorb water and to absorb and release chemical substances.[1,4] The phenomenon of sorption and solubility can be due to several physical and chemical processes. This leads to an effect on the structure and function of the polymeric material which includes volumetric change as expansion, physical changes as plasticizing, and chemical changes such as oxidation and hydrolysis.[1,6] The sorption and solubility rate of these materials can be influenced by the individual composition of each the hydrophilic character of matrix, the degree of conversion, and the solvent. There have been studies which reported that sorption and solubility are dependent on the immersion time and pH of the solution.

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Mouthwashes are of many varieties which are used for maintaining oral hygiene.[8] Mouth rinses are widely used to prevent and control caries and periodontal disease, even without a dental prescription.[9] It is also commonly used for rinsing at times to minimize plaque accumulation.[8] Mouthwashes are often used as deodorant and has refreshing.[9] A previous study states that some individuals used mouth rinses with a frequency of up to 6 times/day.[10,11] The various substances which are available in mouthwashes are water, antimicrobial agents, salts, preservatives and, in some cases, alcohol. Some mouthwashes contain alcohol which ranges up to 27%, while others contain no alcohol.[8] The variation in the concentration of these substances will affect the pH of mouth rinses.[12] There are still studies that are being done to study the effects of these components in the polymer matrix of the composite resins. Mainly, alcohol has an effect of softening the composite surface by removing monomers, oligomers, and linear polymers of the formed polymer surface.[13-16] Opening of the polymer surface can also occur which leads to decreased hardness and increase wear of the material.[1] Commercially available mouth rinses are either alcohol-based, fluoride-based, or chlorhexidine gluconate based mouth rinses.[17]

Since there have been many studies stating that composite resin is shown changes in the oral environment, when it is subjected to mouthwashes it will also cause changes. Thus, seeing that there is an effect of mouthwashes on the properties of composite resin, the aim of this study is to evaluate the effect of mouthwashes which contain alcohol and mouthwash that does not contain alcohol on different composite resins by evaluating the sorption rate.

MATERIALS AND METHODS

Restorative Materials and Solutions

Three types of composite resins were used. The restorative materials were micro hybrid, fine hybrid, and nano hybrid. Table 1 shows the content of each composite resin used in this study. The solutions that were used in this study are the mouthwashes that are commercially available. Commonly used for the maintenance of oral hygiene of a patient, one mouthwash containing alcohol (Listerine) and one mouthwash that does not contain alcohol (Colgate) and a deionized distilled water as a control. Table 2 shows the composition of the mouthwashes which were used in this study.

Preparation of Specimen

Fifteen cylindrical specimens were prepared for each of the composites. The dimension in which the samples were made was 15 mm in diameter and 2 mm in height. The resin composites were dispensed, manipulated and polymerized according to the manufacturer's instructions. The composites were light-polymerized using curing light unit.

Sorption Measurements

The measurements of the composite resins sorption were determined. The baseline weight of each of the composites was weighed and recorded. After determining the weight of the resin composites, they were stored separately in 2 ml of each solution, Listerine, Colgate and distilled water for 24 h and 48 h. After 24 h from the initial weighing period, the samples were removed from the solutions using tweezers, excess fluid that was present on the surface on the sample was removed using a paper towel. Then, the samples were weighed. This is to obtain the weight of the samples after immersion in solutions. This weighing step was done 3 times consecutively. The weight was recorded then a mean value was obtained. The samples were then placed back into the respective solutions, and the samples were weighed again after 24 h. This is to obtain the 48 h reading.

Statistical Analysis

All the data were obtained and recorded, the data obtained have normal distribution of error and were analyzed by one-way ANOVA, considering the composite resins and mouthwashes as the main factor under study. *Post hoc* Tukey test was used to compare means of sorption in studied factors. To evaluate the effect of alcohol on the sorption of the composite resins.

RESULTS

The results of the sorption test of the composite resins which were subjected to different solutions were recorded and tabulated in Tables 3-5. The baseline denotes the initial weight of the composite resin before placing them in the solutions. Day 1 is after 24 h and day 2 is after 48 h. Based on the data collected, it was seen that the nano hybrid composite resin weighed the most.

With respect to the sorption caused by the mouthwashes between three composite resins used, it was found that it was a greater extent in Listerine for the micro hybrid composite. As Listerine contains alcohol it has a greater influence in the sorption rate of the composite; however, it was not displayed in fine hybrid and nano hybrid. In Colgate, there was an increase in the weight of all the composites in day 1 and a drop in the weight in day 2. Similarly, in distilled water, there was an increase in the weight of the composites; however, the weight in day 2 remained constant.

It is clearly observed that the mouthwashes containing alcohol in the composition led to higher values in

Table 1: Restorative material used according to composition and classification

Material	Inorganic content	Organic content	% weight of filler content
Nano hybrid composite	Barium aluminum borosilicate	UDMA, Bis-EMA, Bis-GMA	75
Fine hybrid composite	Glass filler amorphous silica	TEGDMA, Bis-EMA, Bis-GMA	78
Micro hybrid composite	Barium aluminum fluoride glass	Bis-GMA, TEGDMA	64

TEGDMA: Triethylene glycol dimethacrylate, Bis-GMA: Bisphenol A-glycidyl methacrylate, UDMA: Urethane-dimethacrylate

Table 2: Composition of mouthwashes used in this study

Mouthwashes	Manufacturer	Composition
Listerine cool mint	Johnson & Johnson Healthcare Prod.	Thymol, eucalyptol, methyl salicylate, menthol, water, sorbitol solution, alcohol (30%), poloxamer 407, benzoic acid, mint and mint essences, sodium saccharin, sodium benzoate, green dye 3
Colgate plax peppermint fresh	Colgate-Palmolive Ind. Com. Ltda.	Aqua, glycerin, propylene glycol, sorbitol, poloxamer 407, aroma, menthol, sodium saccharin, potassium sorbate, sodium fluoride, blue dye

Table 3: Comparison of sorption rate in distilled water

Resin composite	Baseline	Day 1	Day 2
Fine hybrid	0.538	0.546	0.55
Micro hybrid	0.536	0.54	0.542
Nano hybrid	0.5982	0.612	0.61

Table 4: Comparison of sorption rate in Colgate

Resin composite	Baseline	Day 1	Day 2
Fine hybrid	0.5436	0.568	0.562
Micro hybrid	0.536	0.572	0.56
Nano hybrid	0.612	0.64	0.628

Table 5: Comparison of sorption rate in Listerine

Resin composite	Baseline	Day 1	Day 2
Fine hybrid	0.5434	0.572	0.560
Micro hybrid	0.5416	0.574	0.586
Nano hybrid	0.5976	0.634	0.628

the sorption. Figures 1-3 show the distribution of the weight from the baseline weight until day 2 readings.

Charts depict the change of weight of the composite resins when subjected to different mediums.

DISCUSSION

Sorption is a diffusion-controlled process that occurs in composite resin. The sorption of a composite resin depends on the potential hydrophilicity and the chemical composition of their filler particles. Depending on the composition of the composite resins, the kinetic process can be slower or faster for some composites.[18] When the composite is immersed in water, there are two different mechanisms that will occur. First, there will be an increase in the mass of the composite resins due to the accumulation of water particles in the micro spaces between the filler and resin. This can cause a hydroscopic expansion which can cause defects to the composite resin such as color changes, degradation of the filler/matrix combination, reduction of hardness, and wear resistance. Next, the particles or residual monomers, small polymer chains and particle ions get leached out which results in a loss of mass. This phenomenon is known as solubility.[4,19]

In a study by Leal, it was stated that among the composite resins that they have used, it was found that there was a greater degree of sorption and solubility in Opallis Flow compared to the other composites. Opallis Flow was the one with the worst performance. This was explained because Opallis Flow had triethylene glycol dimethacrylate (TEGDMA) in its composition by it differed from the other composites used due to the presence of other monomore such as urethane-dimethacrylate (UDMA) or bisphenol A-glycidyl methacrylate (Bis-GMA), which are less hydrophilic than TEGDMA. TEGDMA is a type of monomer which is present in composite resins.[1] This monomer has greater hydrophilicity and greater sorption capacity. Zhang and Wu[20] have found two dental composites based on the monomer content, Bis-GMA, UDMA, and TEGDMA showed to have 2 times higher sorption values in ethanol/water than in artificial saliva.

Muller *et al.*[21] stated that Bis-GMA based polymers are highly susceptible to chemical softening. This chemical softening can influence the strength of the composite resin. Another author has demonstrated that softening can decrease the compressive strength of composites which are stored in mediums such as ethanol and organic acid which are often present in plaque.[21,22] It is important to increase the longevity of the composite, and it was found that by increasing the degree of conversion in a composite it aids in lowering

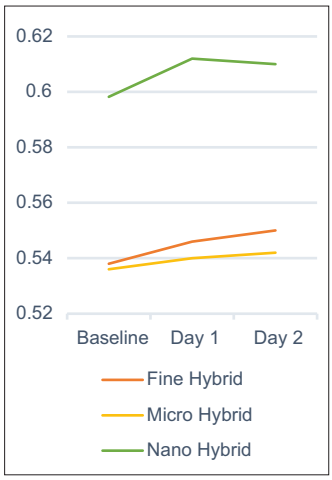

Figure 1: Distilled water

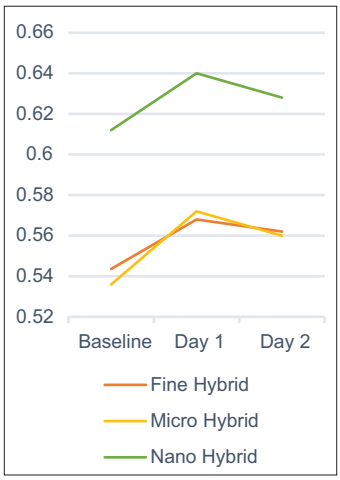

Figure 2: Colgate

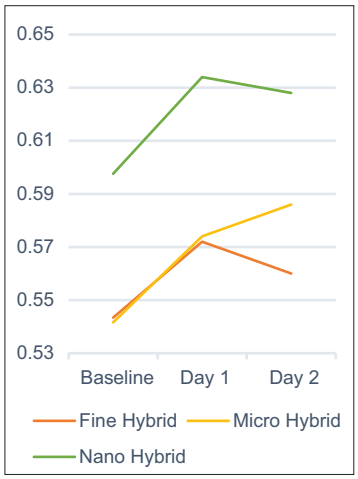

Figure 3: Listerine

the solubility of the composite thereby lessening the softening effect.[23] Geurtsen *et al.*[20] stated that the higher organic matrix of hybrid materials could be a reason for the higher susceptibility to water absorption and material disintegration. The hydrophobic matrix of the resin composite material may prevent the uptake of water; this matrix contributed to the microhardness of the material. A causative factor of softening of the composite resin surface is alcohol. The monomers are removed from the polymer structure and lead to opening of the polymer structure which causes diffusion of water and saliva that can lead to decrease in hardness, increase in material wear and change in other physical properties.[19,24]

A study conducted regarding the effects of alcoholic and non-alcoholic mouthwashes on heat-treated composite resin found that the disks soaked in Listerine fresh burst, gained significantly more weight when compared to those soaked in the other solutions. It has also been shown that the disks soaked in a solution with a low concentration of alcohol had a weight change similar to those that were in a solution with no alcohol. However, the disks in the solutions with no alcohol showed the least weight gain.[8] The findings from this article are similar to the findings from this study which showed that there was an increase in the weight of the composite mainly the micro hybrid composite when placed in Listerine which contained alcohol. There was no continues weight change of the composite when in other solution after 24 h.

Based on our study, it showed that the micro hybrid composite showed more solubility compared to the nano hybrid and fine hybrid. There is an article which states that the sorption values presented by nanofilled composite were statistically higher than the hybrid composite. It was found that the nanofilled composite was more prone to absorbing more fluid than the other hybrids which were used in their study. They have suggested that due to the presence of silane with the hydrophilic groups, it is capable of forming high levels of hydrogen bonds which is responsible for the high levels of sorption.[10] The composite that was used in this study was hybrid composites whereas in the study which was discussed the composite used was a nanofilled composite. The difference is the filler content which is present in a nano filled and a hybrid composite which influences the sorption and solubility. It was found that the sorption values of the hybrid composite were found to be lower than that of the nanofilled composite when the hybrid composites were subjected to mouthwashes that contain alcohol. There was a higher sorption rate of the hybrid composites when exposed to Plax (content 6%) and was maintained in the control group. However, it was seen that there is an effect of alcohol-containing mouthwashes on the composite resin which is the main aim of this study.

The role of alcohol which is present in the mouthwash has a role as a solvent, flavor enhancer, and an antiseptic agent.[25] As mentioned, there are various types of commercially available mouthwashes which

are used by individuals to maintain oral hygiene and prevent plaque accumulation. These mouthwashes may or may not contain alcohol in their content. There have been many studies which were conducted to test the influence of mouthwashes used on patients who have done composite resin restorations. It has been found that the alcohol content which is present in the mouthwash has an influence on the strength of the composite and compromises its longevity. The weight gain in the composite material is mainly due to the presence of alcohol in the mouthwashes used. Which supports the finding of this study as it is clearly seen in micro hybrid composite resin. It is stated that every commercially available mouthwashes have various ingredients in them that may have a deleterious effect on the composite resin.[8] It was found in general that mouthwashes containing alcohol in their composition showed higher sorption and solubility especially "Listerine with alcohol" which contains the highest alcohol concentration (approximately 30%). This is due to the presence of ethanol in the composition. Ethanol has the ability to penetrate the polymer network of the composite resin causing expansion of the polymer structure, this then allows the release of residual monomers which, in turn, causes dissolution of the linear polymer chain.[26]

CONCLUSION

It can be concluded that the sorption of the composites was higher in mouthwashes containing alcohol. Thus, mouthwashes that do not contain alcohol should be preferred in patient that has done composite resin restorations.

REFERENCES

1. Leal JP, da Silva JD, Leal RF, Oliveira-Júnior CD, Prado VL, Vale GC. Effect of mouthwashes on solubility and sorption of restorative composites. Int J Dent 2017;2017:5865691.
2. Miranda DD, Bertoldo CE, Aguiar FH, Lima DA, Lovadino JR. Effects of mouthwashes on Knoop hardness and surface roughness of dental composites after different immersion times. Braz Res 2011;25:168-73.
3. Anusavice KJ. Phillips' Science of Dental Materials. 11th ed. Rio de Janeiro: Elsevier; 2005.
4. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater 2006;22:211-22.
5. Gonçalves L, Filho JD, Guimarães JG, Poskus LT, Silva EM. Solubility, salivary sorption and degree of conversion of dimethacrylate-based polymeric matrixes. J Biomed Mater Res Part B Appl Biomater 2008;85:320-5.
6. Sideridou I, Tserki V, Papanastasiou G. Study of water sorption, solubility and modulus of elasticity of light cured dimethacrylate-based dental resins. Biomaterials 2003;24:655-65.
7. Silva EM, Almeida GS, Poskus LT, Guimarães JG. Relationship between the degree of conversion, solubility and salivary sorption of a hybrid and a nanofilled resin composite: Influence of the light-activation mode. J Appl Oral Sci 2008;16:161-6.
8. Weiner R, Millstein P, Hoang E, Marshall D. The effect of alcoholic and nonalcoholic mouthwashes on heat-treated composite resin. Oper Dent 1997;22:249-53.
9. Katariya C, Jayalakshmi J. Effect of mouth wash on colour stability on composite resins. Int J Multidiscip Res Mod Educ 2017;3:22-5.
10. Almeida GS, Poskus LT, Guimarães JG, Silva EM. The effect of mouthrinses on salivary sorption, solubility and surface degradation of a nanofilled and a hybrid resin composite. Oper Dent 2010;35:105-11.
11. Moran JM. Chemical plaque control-prevention for the masses. Periodontology 2000;15:109-17.
12. Bhatti SA, Walsh TF, Douglas CW. Ethanol and pH levels of proprietary mouthrinses. Community Dental Health 1994;11:71-4.
13. Aguiar FH, Oliveira TR, Lima DA, Paulillo LA, Lovadino JR. Effect of light curing modes and ethanol immersion media on the susceptibility of a microhybrid composite resin to staining. J Appl Oral Sci 2007;15:105-9.
14. Malacarne J, Carvalho RM, de Goes MF, Svizero N, Pashley DH, Tay FR, *et al*, Water sorption/solubility of dental adhesive resins. Dent Mater 2006;22:973-80.
15. Benetti AR, Asmussen E, Munksgaard EC, Dewaele M, Peutzfeldt A, Leloup G, *et al*. Softening and elution of monomers in ethanol. Dent Mater 2009;25:1007-13.
16. Asmussen E, Peutzfeldt A. Influence of selected components on crosslink density in polymer structures. Eur J Oral Sci 2001;109:282-5.
17. Kirubagaran SS. Effect of fluoride mouth rinses inducing color change in esthetic veneer restoration a spectrophotometric analysis. J Pharm Sci Res 2016;8:210-13.
18. de Moraes Porto IC, Almeida AG. Evaluation of short and medium-term sorption and solubility of methacrylate or silorane-based composite resins in artificial saliva. Rev Odontol 2013;42:176-181.
19. Parolia A, dos Santos Barbosa N. A comparative effect of mouthwashes with different alcohol concentrations on surface hardness, sorption and solubility of composite resins. Oral Health Dent Manage 2014;13:502-6.
20. Geurtsen W, Leyhausen G, Garcia-Godoy F. Effect of storage media on the fluoride release and surface microhardness of four polyacid-modified composite resins (compomers). Dent Mater 1999;15:196-201.
21. Mueller HJ, Bapna MS, Suchak AJ, Stanford JW. Restorative Resins and Mouth Rinses. Abstract, No.828. Journal of Dental Research 61 Abstracts of Papers; 1982. p. 270.
22. Asmussen E. Softening of BISGMA-based polymers by ethanol and by organic acids of plaque. Scand J Dent Res 1984;92:257-61.
23. Wu W, McKinney JE. Influence of chemicals on wear of dental composites. J Dent Res 1982;61:1180-3.
24. Lee SY, Huang HM, Lin CY, Shih YH. Leached components form dental composites in oral simulating fluids and the resultant composite strengths. J Oral Rehabil 1998;25:575-88.
25. Alves AR, Tavares MJ, Costa DA, Ingrid Q. Influence of mouthwashes on hardness of composite resins direct. Rev Odontol Bras Cent 2014;23:100-3.
26. Schmitt VL, Naufel FS, Nahsan FP, Alexandre C. Sorption and solubility assessment of a resin composite in different liquids. Odontol Clın Cient 2011;10:265-9.

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