Influence of alcohol-containing mouthwash and alcohol-free mouthwash towards the hybrid composite restoration materials surface hardness

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ABSTRACT

Mouthwash is widely used by the community to maintain oral health. Beside the benefit provided, both alcohol-containing mouthwash and alcohol-free mouthwash have negative effects on the composite resin restorative materials, which can affect the surface hardness. One of composite types is hybrid type which is superior in physical and mechanical properties as a restorative material. The aim of this study was to determined the effect of alcohol-containing mouthwash and alcohol-free mouthwash towards the surface hardness of hybrid composite restorative material. This study used 15 disc-shaped specimens of hybrid composite with the size of 6 mm diameter and 4 mm thickness and divided into three treatment groups immersion, in the alcohol-containing mouthwash (A), alcohol-free mouthwash (B), and artificial saliva (C) as control for 12 hours, which surface hardness was further tested using Vickers hardness test. The mean of hardness values of group: A 24.9 VHN; B: 27.2 VHN; and C: 28.4 VHN. The results of statistical tests One-Way ANOVA showed there were significant differences in the hardness values among the three treatment groups ($p<0,05$). From this study concluded that both alcohol-containing mouthwash and alcohol-free mouthwash were decreasing the surface hardness of hybrid composite restorative material.

Keywords: Alcohol-containing mouthwash, hybrid composite, restorative resin, alcohol-free mouthwash, surface hardness.

INTRODUCTION

Mouthwash is widely used by the general public to maintain hygiene and health of the oral cavity in addition to brushing teeth and the use of dental floss. The use of mouthwash is done on the consideration of its benefits in preventing various mouth diseases such as gingivitis, periodontitis, caries, and also as a remover of bad breath. This benefit arises because the substances contained in the mouthwash can inhibit growth and kill bacteria in the oral cavity.[1,2] These active substances include essential oils, Chlorhexidine, Fluoride, Benzydamine, Potassium Nitrate, and alcohol. Alcohol added in mouthwash to be functioned as a solvent for other active substances, preservatives, and antiseptics.[3,4]

In addition to the benefits provided, mouthwashes can also have an adverse effect

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on the soft tissues of the oral cavity, such as an increased risk of ulcers and malignancies in the oral cavity, especially from the alcohol-containing mouthwashe.[5,3] Research conducted by Asmussen in 1984 showed that not only its effects on the oral cavity, alcohol content in mouthwash can also affect the mechanical properties of resin-containing restorative material.[6] One of the most widely used resin restorative materials in the field of dentistry is composite resins. This material has advantages in its properties especially its aesthetic properties, so it is often used for anterior teeth restoration. One type of composite used for this anterior restoration is the hybrid type. This type also has advantages in surface smoothness and adequate strength.[7,8]

The hardness of composite restorative materials may be decreasing due to the influence of mouthwash, this will have an impact on the clinical endurance of a restoration. Both alcohol-containing mouthwash and alcohol-free mouthwash will have an effect on composite surface hardness.[1,9] Therefore, in order to maintain the stability of its properties, it is necessary to determine how much of the effects of both alcohol-containing mouthwash and alcohol-free mouthwash towards the surface hardness of the composite restorative material.

Based on the background that has been described above, the authors were interested to examine the influence of alcohol-containing mouthwash and alcohol-free mouthwash towards the surface hardness of hybrid composite restoration materials. The purpose of this research was to determined the effect of alcohol-containing mouthwash and alcohol-free mouthwash towards the surface hardness of hybrid composite restorative material.

METHODS

The study type was purely experimental in-vitro conducted to assess the changes in the surface hardness of hybrid composite restoration materials due to the influence of alcohol-containing mouthwash and alcohol-free mouthwash. The sample used was 15 pieces of Cavex® hybrid composite disks with thickness diameter of 6 mm and 4 mm.

RESULTS

This research used 3 test in the immersion treatment conditions which consisted of 5 samples. Group A was immersed in an alcohol-containing mouthwash, group B in an alcohl-free mouthwash, and group C in artificial saliva as the control group. The three groups were then tested for hardness using Vickers Hardness Tester with 5 indentation points on each sample as shown in Figure 1. From the measurement result, obtained data of surface hardness value of each group presented in Table 1.

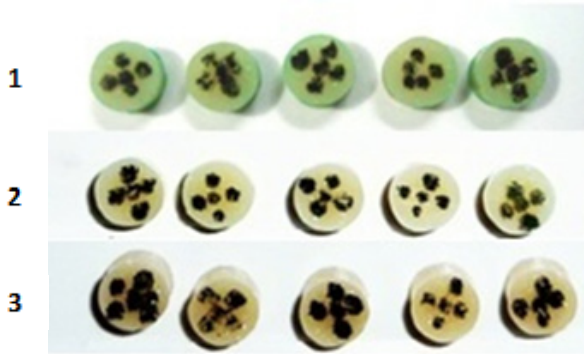

Figure 1. The three sample groups have been tested for surface hardness. The black dot was the reference point where the indentation point was marked with ink. 1: Group A sample; 2: Group B sample; 3: Group C sample

Table 1. Surface hardness data of composite restorative material on 3 immersion treatment conditions

Sample	Surface hardness value (in VHN unit)		
	Group A	Group B	Group C
1	24.88	25.86	27.50
2	25.72	27.14	27.94
3	25.14	26.50	28.54
4	23.40	28.10	28.48
5	25.40	28.40	29.52
Average	**24.9**	**27.2**	**28.4**

The results of the surface hardness test were then analyzed using the One Way Anova (One-Way ANOVA) statistical test. In this test, the first step was to test the data normality using the Kolmogorov-Smirnov normality test method to determined whether the whole group of data distributed normally meaning there was no extreme values that make the data becomes invalid. Furthermore, the homogeneity test of

variance was performed to see whether the values of variance obtained were uniform and it was found that the surface hardness of the composite restorative materials of the three groups of data tended to be different.

The result of Post Hoc Test using Multiple Comparisons Tukey HSD method was showed in Table 2 which suggested that there were significant differences ($p<0.05$) among the group A and group B; group A and group C; and group B with group C.

All the statistical analysis calculations presented in Table 2 were described in Figure 2 which was illustrating the average comparison of the surface hardness values of the three groups.

DISCUSSION

The sampling process in this study was using a mold that produce a disk-shaped sample. The composite restoration material was inserted into the mold and polymerized in layers to fill the mold so that each layer of the material was polymerized resulting in a sample having good strength and hardness. This study examined the surface hardness of the samples, so that a sample with a flat and smooth surface can be obtained from the application of strip mat or polishing, because in its hardness testing process, the Vickers Hardness Tester indentor can only

Table 2. Multiple Comparisons Tukey HSD results

Immersion treatment (i)	Immersion treatment (J)	Mean Difference (I-J)	Standard error	Significance
Alcohol-contained	Alcohol-free	-2.29200*	.57940	.005
	Artificial saliva	-3.48800*	.57940	.000
Alcohol-free	Alcohol-contained	2.29200*	.57940	.005
	Artificial saliva	-1.19600*	.57940	.049
Artificial saliva	Alcohol-contained	3.48800*	.57940	.000
	Alcohol-free	1.19600*	.57940	.049

*** Mean difference value was significant at the level of 0.05**

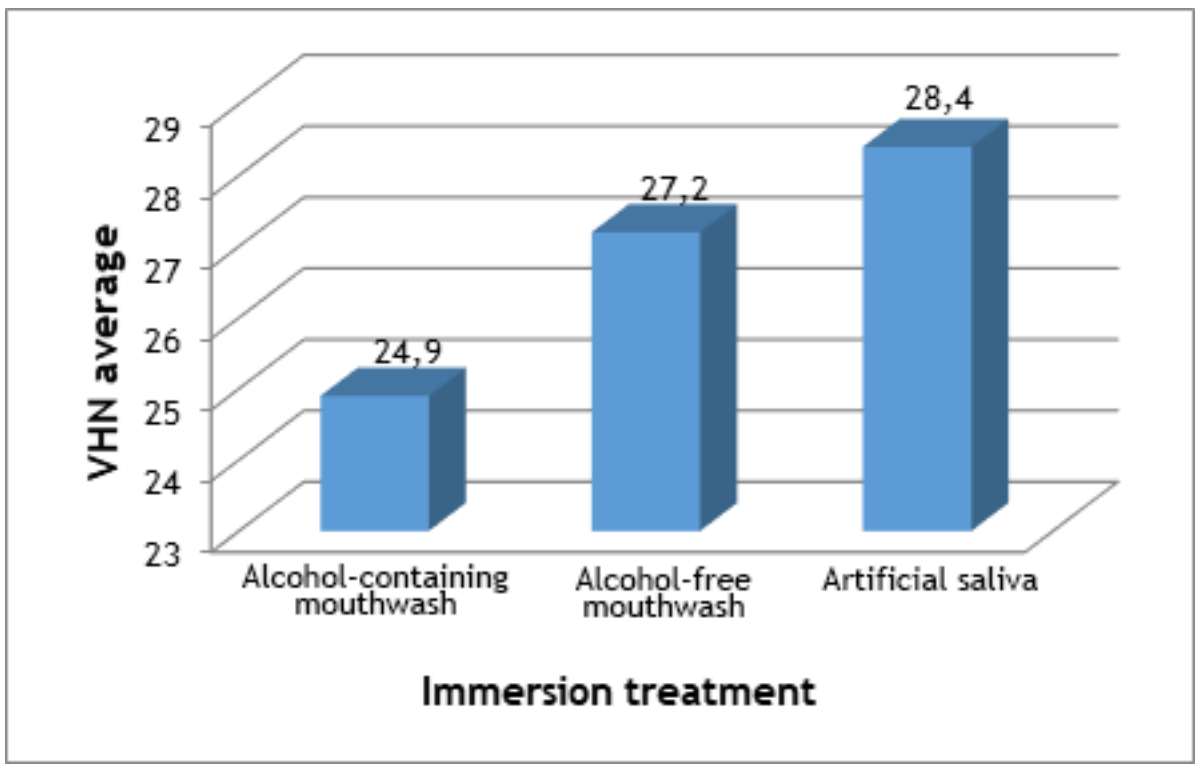

Figure 2. Comparison of the average value of surface hardness of hybrid composite in different immersion treatment

indexing the flat sample. Based on research that has been done Celik and Ozgünaltay in 2009, the most refined surfaces on composite restoration materials can be obtained by using the matrix strip[10]. Sampling in this study used a matrix strip of celluloid applied over the surface of the material and pressed with a pressure on the mold to obtain the desired surface of the sample.

The immersion process begun by immersing the sample in artificial saliva for 24 hours firstly. The purpose of this immersion was to allow post-irradiation and post-setting hardening of the material.[9]. The composite polymerization reaction will continue for 24 hours even though the material is already visibly hardened after initial polymerization with rays.[11] Immersion for 24 hours will produce the sample with its optimum properties before immersed in the liquid to be tested afterwards.

The next stage was divided the sample into 3 groups immersed in alcohol-containing mouthwash, alcohol-free mouthwash, and artificial saliva for 12 hours with the assumption of a minimum time of 1 year old mouthwash for 2 minutes per day.[10,12] This condition indicated excessive use of mouthwash. This step was performed to see the decrease in hardness of composite restoration materials.

According to Powers and Sakaguchi in 2006, the negative effects of mouthwash occurred in high alcohol content and excessive use of mouthwash. The higher the alcohol content in mouthwash will cause a higher influence on the composite resin restoration material.[11] The longer the material is exposed to a substance, the greater the change that the material will experience.

Hardness is the resistance of a material surface to indentation or penetration.[13,11] The surface hardness of restorative ingredients in in vivo situations can be influenced by various factors such as food, beverages, and in this case mouthwash also affects. The change in hardness can be affected by composition, storage time, and material storage media.[12]

The results of the research and statistical analysis that have been done showed that there was differences of mean surface hardness value from each group. As presented in Table 1, the average surface hardness value of hybrid composite restorative materials after immersion in an alcohol-containing mouthwash was 24.9 VHN; in alcohol-free mouthwash was 27.2 VHN; and in artifficial saliva was 28.4 VHN. Based on the ANOVA One-Way analysis results, the values obtained showed significant differences in hardness of composite restoration materials among the three groups. The results showed that when compared to groups immersed in artificial saliva (as controls), the other two groups immersed in both alcohol-containing mouthwash and alcohol-free mouthwash were having a decreased level of surface hardness.

The decrease of hardness value was very visible in the alcohol-containing mouthwash treatment group, which was 24,9 VHN. The difference in the surface hardness value was also statistically significant. The results of this study corroborated another study suggested that alcohol content in mouthwash may lead to softening of resin restorations, in this case a decrease in hardness in composite resin restoration materials.[11]

The results of the study have been conducted in line with previous studies that show similar results, that alcohol-containing mouthwash provide the highest rate of decreased hardness compared to other mouthwash.[1,9] The softening of the composite material occurred due to an irreversible process such as the release of the material component by the influence of ethanol. The mechanical properties of the restorative material may be disrupted after immersion because when ethanol permeates into the composite matrix, the polymer chain expands and the monomers in it can be released.[14,15]

The chemical composition of the composite resin material may affect susceptibility to softening and degradation. According to Gurdal et al.[16] in 2002, polymers based on Bis-GMA and UDMA are susceptible to softening chemically by ethanol,[10,17] whereas in TEGDMA, the monomers have a lower molecular weight producing a matrix more resistant to degradation by solvent[7]. The hybrid composite restoration material used in this study contains Bis-GMA as its organic matrix. Gurdal et al. in 2002 had mentioned that softening of the GMA-Bis can be easier because the matrix has higher viscosity and water sorption properties than UDMA.[16,12]

Other factors that influence the decrease in hardness value are alcohol concentration and

fluid pH. The pH value of the fluid used has a great influence on the degradation of the composite organic matrix. Mouthwashes with a low pH and high alcohol content may affect some of the mechanical and physical properties of composite resins.[17,18]. In this study, alcohol-containing mouthwash has the lowest pH of 5.3; while alcohol-free mouthwash 5,8; and artificial saliva was 6.9. Diaz-Arnold et al. in 1995 stated that the low pH of the media affects the chemical erosion of hybrid restorative materials by etching the surface acid of the material and releasing major cations in the formation of matrices such as Ca, Na, Al, and Sr.[15,9] Other studies also suggest that a low pH of a liquid may trigger hygroscopic uptake and expansion that would cause the degradation process.[18]

The low pH concentration of the mouthwash may react with the hybrid composite polymer matrix by removing the ester group from the dimethacrylate monomer present in the ingredients composition (Bis-GMA, UDMA, TEGDMA). The hydrolysis reaction of this ester group may form molecules of alcohols and carboxylic acids which can accelerate the degradation of the resin composite material due to the low pH in the matrix. Even low pH values can cause surface erosion of the filler, accelerate the debonding, and increase the release of ions from its surface.[17]

The results showed that the value of sample hardness immersed in alcohol-free mouthwash (27.2 VHN) also decreased compared with samples immersed in artificial saliva (28.4 VHN). The hardness values at the first glance appear not so much different, but based on the results of the Tukey HSD test between groups, a significant difference in hardness of composite restoration materials between immersion in alcohol-free mouthwash and immersion in artificial saliva. The pH of the alcohol-free mouthwashes was also low, at 5.3. So that the degradation of the surface of the composite resin material also occurred due to the effect of immersion. This means that both alcohol-containing mouthwash and alcohol-free mouthwash can affect the hardness of the hybrid composite restoration opening.

This proves that alcohol content is not the only factor in mouthwash that has a softening effect on composite restorative materials, but indeed a higher reduction of hardness occurs due to the influence of mouthwash containing alcohol. However, other ingredients in mouthwash may also affect the reduction of surface hardness of hybrid composite restoration materials.[1,9]

The effect of mouthwash on the change in surface hardness of the restorative material may be derived from the composition of the restorative material itself and of the composition and duration of immersion in the mouthwash used. Clinically, the effect of mouthwash on composite resin restorative materials depends on saliva, salivary pellicle, food, beverages, and oral care products. These in-vivo factors act in an isolation that may disrupt the physical and mechanical properties of the material and affect the endurance of a restorative material and can not be tested in-vitro in this study.[10,17]

CONCLUSION

Both alcohol-containing mouthwash and alcohol-free mouthwash were decreasing the surface hardness of hybrid composite restorative material, with a higher decreasing value of found in the immersion in an alcohol-containing mouthwash than in alcohol-free mouthwash and artificial saliva.

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