Journal of Research in Medical and Dental Science
2018, Volume 6, Issue 2, Page No: 222-226

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Effect of Pepsi and 40% Hydrogen Peroxide on Microhardness of Amaris Composite Resin: An *In Vitro* Experimental Study

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DOI: 10.24896/jrmds.20186234

ABSTRACT

The purpose of this study was to evaluate the effect of Pepsi and 40% hydrogen peroxide on microhardness of Amaris composite resin. In this in vitro experimental study, 30 cylindrical samples of Amaris composite resin (6 mm in diameter and 2 mm in thickness) were fabricated and light-cured. Samples were divided into three groups (n=10). Ten composite samples were stored in distilled water at 37°C and served as the control group. Ten samples were exposed to 40% hydrogen peroxide bleaching gel for six and 42 hours (first experimental group). The remaining 10 samples were stored in Pepsi for six and 42 hours. The microhardness of composite samples was measured using Vickers microhardness tester under 100 g load applied for 10 seconds before and after the intervention. The obtained data were analyzed using SPSS 16 via one-way ANOVA and post hoc test ($P \leq 0.05$). Microhardness of composite decreased at both six and 42 hours after immersion in water ($P=0.048$), Pepsi ($P<0.001$) and %40 hydrogen peroxide ($P<0.001$). Comparison of the three groups showed significant differences between the Pepsi and 40% hydrogen peroxide groups at baseline ($P=0.011$), distilled water and 40% hydrogen peroxide at six hours ($P=0.004$), distilled water and Pepsi at 42 hours ($P=0.003$) and distilled water and 40% hydrogen peroxide at 42 hours ($P<0.001$). According to the results of this study, water, Pepsi and 40% hydrogen peroxide all decrease the microhardness of Amaris composite resin.

Keywords: Microhardness, Composite, Dental Restorative Material, Cola, Hydrogen Peroxide

HOW TO CITE THIS ARTICLE: Somayyeh Hoseini Tabatabaei, Aliyeh Sehatpour, Mohammad Sadegh Abedinejad, Fatemeh Kadkhodaei Oliadarani, Effect of Pepsi and 40% Hydrogen Peroxide on Microhardness of Amaris Composite Resin: An *In Vitro* Experimental Study, J Res Med Dent Sci, 2018, 6 (2): 222-226, DOI: 10.24896/jrmds.20186234

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Received: 11/12/2017
Accepted: 14/02/2018

INTRODUCTION

Restorative materials are constantly exposed to the saliva and its chemical constituents, foods and drinks, which can gradually wash away the resin matrix and subsequently the filler particles [1,2]. Surface hardness is an important mechanical property of restorative materials. Reduction in microhardness leads to disintegration and roughness of the surface and consequently results in plaque accumulation and deposition of lactic acid [3]. Despite numerous studies on the efficacy and complications of bleaching agents, there are still some issues in this regard such as the effect of bleaching agents on restorative materials and particularly composite restorations. The current in vitro study aimed to assess the effect of Pepsi Cola and hydrogen peroxide bleaching gel on hardness of composite resin.

MATERIALS AND METHODS

This in vitro, experimental study was conducted on Amaris Translucent composite resin (Voco, Cuxhaven, Germany). Composite was applied into transparent polyvinyl siloxane cylindrical molds measuring 6 mm in diameter and 2 mm in height. The upper and lower surfaces of the mold were covered with a celluloid tape and a glass slab was placed on top of it. Pressure was applied in order for the excess material to leak out. According to the manufacturer's instructions, composite was light-cured for 40 seconds from each side using a halogen light curing unit (Farazmehr, Isfahan, Iran) with a light intensity of 500 mW/cm^2. Thirty composite cylinders were fabricated as such and were randomly divided into three groups of 10 [4]. To assess the hardness of samples, microhardness tester (MXT-AL, Buehler, USA) was used. The microhardness of samples was measured by applying 100 g load for 10 seconds to create three indentations at the center of the upper surface of samples. Load was applied by the indenter of the device in the form of a plus sign (+). The vertical and horizontal dimensions of the plus sign were then measured to calculate the mean hardness number according to the Vickers table. The mean value was reported as the Vickers hardness number of each sample.

After measuring the initial hardness number of samples, group 1 samples were immersed in distilled water and their hardness was measured again after six and 42 hours of immersion. In group 2, the samples were subjected to 40% hydrogen peroxide gel according to the manufacturer's instructions. For this purpose, gel with 2 mm thickness was applied on the composite samples for 15 minutes. The gel was then washed and reapplied for the same period of time. In the time interval between the two applications, the samples were rinsed under running water and immersed in distilled water for one minute. This procedure was repeated 42 hours later.

In group 3, samples were immersed in Pepsi Cola for six hours a day at 37°C and stored in distilled water at 37°C for the rest of the day. The microhardness of the samples was measured after six hours (one day) and 42 hours (seven days). Data were analyzed using non-parametric Mann Whitney and Wilcoxon tests.

RESULTS

Table 1 shows the mean and standard deviation of hardness number of samples in the three groups at baseline and six and 42 hours after the intervention. As shown in Table 1, one-way ANOVA demonstrated that the difference in the mean hardness number of the three groups was statistically significant at baseline (P=0.014), six hours (P=0.005) and 42 hours (P<0.001).

Also, as illustrated in Table 1, repeated measures ANOVA, applied for the comparison of the mean hardness at different time points within each group, revealed that the mean difference in hardness at different time points was marginally significant in distilled water group (P=0.048). This difference was statistically significant in Pepsi and 40% hydrogen peroxide groups (P<0.001).

The Post hoc test was then applied for pairwise comparison of the groups. Table 2 displays the pairwise comparison of hardness in the three groups at baseline, six hours and 42 hours after the intervention. There were shown the significant differences between the Pepsi and 40% hydrogen peroxide groups at baseline (P=0.011), distilled water and 40% hydrogen peroxide at six hours (P=0.004), distilled water and Pepsi at 42 hours (P=0.003) and distilled water and 40% hydrogen peroxide at 42 hours (P<0.001).

Table 1: Mean and standard deviation of hardness number of samples in the three groups at baseline, six hours and 42 hours after the intervention

Group	Mean ± SD			P value
	Baseline	6 hours after	42 hours after	
Distilled water	55.24 ± 4	54.27 ± 4.52	53.50 ± 3.22	0.048
Pepsi	57.29 ± 3.6	50.33 ± 2.5	45.41 ± 3.50	<0.001
%40 hydrogen peroxide	52.12 ± 3.2	48.01 ± 4.4	42.56 ± 7.10	<0.001
P value	0.014	0.005		

Table 2: Pairwise comparison of hardness in the three groups at baseline, six hours and 42 hours after the intervention

Group	P-value		
	Baseline	6 hours after	42 hours after
distilled water	0.157	0.004	P < 0.001
Pepsi	0.435	0.084	0.003
%40 hydrogen - peroxide	0.011	0.400	0.419

Table 3 demonstrates the pairwise comparison of the mean hardness number at different time points within each group. At P=0.05 level of significance, comparison of the mean hardness at different time points in Pepsi group revealed significant differences between baseline and six hours (P<0.001), baseline and 42 hours (P<0.001) and six hours and 42 hours (P=0.001). In 40% hydrogen peroxide group, significant differences were noted between baseline and six hours (P=0.019), baseline and 42 hours (P=0.003) and six hours and 42 hours (P=0.005).

Table 3: Pairwise comparison of the mean hardness number at different time points within each group

Group	P-value		
	Baseline	6 hours after	42 hours after
distilled water	0.413	0.693	0.128
Pepsi	P < 0.001	0.001	P < 0.001
%40 hydrogen - peroxide	0.019	0.005	0.003

DISCUSSION

Vickers hardness tester was used in this study to assess the hardness of composite surface, which was in agreement with the methodology of Yanikoglu *et al.,* [2], Medeiros et al. [3], Okada et al. [5], Carreiro *et al.,* [6], and Ateyah *et al.,* [7] but was different from that of Miranda et al. [8] and Cavalcanti *et al.,* [9] since they used other devices/tests for assessment of hardness of composite resin, which may affect the results. For assessment of hardness in the current study, 100 N load was applied in 10 seconds, which was similar to the methodology adopted by a previous study [3]. Khamverdi *et al.,* [4] and Yap *et al.,* [10] applied 300 g and 500 g loads for this purpose, respectively. The magnitude of load applied in the Vickers test depends on the type of composite resin to be tested. If the composite is fragile, lower loads should be applied. Application of excess load in such cases results in molecular fracture of composite at the site of load application and consequently, the diameters of the indentation cannot be measured and the area is visualized as a dark gap.

Several factors affect the hardness of composite resin such as the degree of conversion and polymerization of resin matrix, chemical composition of resin and size, shape and dispersion of fillers [11-14]. The smaller the filler particles, the greater the light scattering would be when curing the composite and consequently, its degree of conversion decreases, which results in lower hardness number [14,15]. In this study, we tried our best to obtain similar samples to increase the accuracy of analyses and results.

This study assessed the effect of 40% hydrogen peroxide whitening gel and Pepsi on hardness of a nanohybrid composite (Amaris). Thirty composite discs were fabricated and divided into three groups of distilled water, Pepsi and 40% hydrogen peroxide. The hardness of these samples was measured before immersion and six and 42 hours after immersion. A can of Pepsi contains about 300 mL of Pepsi. Assuming that in each sip, the teeth are exposed to about 30 mL of Pepsi for approximately six seconds, drinking one can of Pepsi equals 60 seconds of exposure of teeth to Pepsi. Thus, six hours of immersion of samples in Pepsi corresponds to daily exposure of teeth/restorations to Pepsi for one year; 42 hours of immersion equals seven years of frequent use of Pepsi. We measured the hardness by Vickers test and applied 100 g load for 10 seconds.

Our results showed that the mean hardness number of composite samples decreased after six and 42 hours of immersion in distilled water compared to the baseline value (P=0.048). This result was in line with that of Yanikoglu *et al.,* [2], Yap *et al.,* [16], Ratto de moraes *et al.,* [12], Catelan *et al.,* [17], and DaneshKazemi *et al.,* [18]. This reduction in hardness may be due to incomplete polymerization reaction of composite resin. In a study by Mottaghi *et al.,* [14] hardness of all composites decreased six hours after immersion in distilled water compared to the baseline value, but after 42 hours of immersion in distilled water, their hardness increased, which may be attributed to higher cross-linking reactions and completion of polymerization of resin matrix [2,14]. However, Fatima *et al.,* [19] and OS *et al.,* [20] reported that hardness of samples did not change after their immersion in distilled water.

The effect of whitening agents on the hardness of restorative materials is a controversial topic. A previous study reported microstructural changes and reduction in hardness of restorative materials due to the loss of matrix and crack formation at the matrix-filler interface after whitening [21]. However, studies by Taib *et al.,* [22], Costa *et al.,*

[23], Sharafeddin *et al.,* [24], Nattoo *et al.,* [25], and Yap *et al.,* [10] reported no or small changes in properties of the restorative materials after bleaching. Our study also showed that the mean hardness of composite decreased after six and 42 hours of immersion in 40% hydrogen peroxide compared to baseline (P<0.001). Hydrogen peroxide breaks down into two hydroperoxyl radicals (H2O2O) and O serves as the active agent in whitening agents. The hydroperoxyl radical is an active free radical with very high oxidizing potential. It not only affects the pigment molecules but also influences the resin matrix and leads to degradation and softening of composite resin [26]. According to Bailey *et al.,* [27] controversial results regarding the effect of whitening agents on the hardness of tooth-colored restorative materials are probably due to the difference in susceptibility of composites to bleaching agents.

Difference between our results and those of some previous studies may be explained by the difference in type of restorative materials (since some tooth-colored restorative materials are more susceptible), duration of application of bleaching agent, type and concentration of the bleaching agent, pH of the bleaching agent, use of remineralizing solutions, type of hardness test and the amount and duration of load application [24, 28, 29].

We also assessed the effect of immersion of composites in Pepsi and found that the hardness of samples significantly decreased six and 42 hours after immersion (P<0.001). This result was in agreement with that of Mottaghi *et al.,* [14], Narsimha [30], Rugg-gunn *et al.,* [31], and Grando *et al.,* [32]. All these studies showed that acids present in soft drinks decreased the hardness of restorative materials. However, the magnitude of this reduction varied and some reported significant while some others reported insignificant effects of soft drinks on hardness of composite resins [33].

CONCLUSION

According to the results of this study, hardness of composite decreases after immersion in distilled water, Pepsi and 40% hydrogen peroxide. Further studies with larger sample size and longer duration are required on different types of composite resins preferably in the oral environment.

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