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The effect of drinking yogurt on the microhardness of posterior composites resin

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Abstract

Background :This study was conducted to evaluate the effect of yogurt on the surface microhardness of two types of composite resins; (Filtek™ P90 Low Shrink Posterior Restorative, 3M ESPE,USA), and (Filtek™ Z350 Posterior Restorative, 3M ESPE,USA).

Forty samples of composite were prepared by using cylindrical mold (2mm in hight and 8mm in diameter)..All specimens were stored in plastic container that contain distilled water and incubated 37cº for 24 hours before they were tested. twenty samples of each type of composite were divided into two groups (10) for each , baseline measurements for surface microhardness test was taken for all composite samples using the micromet microhardness tester (Vichers hardness tester) with a l00g load was applied for 15 seconds in which three indentations were made for each sample and converted into Vickers Hardness Number (VHN) .After baseline measurement 10 samples of each type of composite were alternately immersed manually by holding the specimen by a pair of tweezers from its sides, , in drinking yogurt (Activia ,KSA) and artificial saliva for 10 cycles 5 seconds each at room temperature (25cº)**.** This was repeated three times a day (8am,4pm,12am) at 8hours intervals for one week. the other 10 samples for each type of composite were immersed in artificial saliva only. The total soaking time in both drinking yogurt and saliva was 100 seconds. After the soaking sequence was completed the specimen was rinsed with distilled water and subjected to surface microhardness test (Vichers hardness tester).

Descriptive statistics(mean values and standard deviations with the minimum and maximum values and Statistical analysis of data by using student t - test for all groups was carried out between the means of each type of composites ,the results showed a significant reduction in VHN values (at $P<0.05$)of Filtek™ Z350 Posterior Restorative composites after immersion in artificial saliva, while the (Filtek™ Z350 Posterior Restorative, 3M ESPE) composite showed a highly significant reduction in VHN values (at $P<0.01$)after immersion in drinking yogurt. Filtek™ P90 Low Shrink Posterior Restorative composites showed a non significant reduction in VHN values (at $P>0.05$) after immersion in artificial saliva and after immersion in drinking yogurt.

Filtek™ P90 Low Shrink Posterior Restorative composites have highest VHN value than Filtek™ Z350 Posterior Restorative composites, and surface microhardness results showed that drinking yogurt highly significantly effect on the Filtek™ Z350 Posterior Restorative composites while it has non significant effect on the Filtek™ P90 Low Shrink Posterior Restorative composite

Keywords: composite resin, drinking yogurt, microhardness

Introduction

In dentistry today, resin composite materials are highly esteemed because of the unanimously acclaimed advantages: superior esthetics quality, high mechanical strength, ease of application, and cost effectiveness [1].

The chemistry of dental restorative composites started in the late 1940s.Since then many technological developments have significantly improved the clinical performance of dental resin composites. The organic matrix is the responsible for the improvements in the mechanical properties, and influences the optical properties[2]. However, the chemical basis for all restorative composites remained the radical polymerization of methacrylates or acrylates and nowadays composites practically employ dimethacrylates such as TEGDMA, MUDMA or Bis- GMA. The low-shrinking Filtek™ Silorane Low Shrink Posterior Restorative is based on the new ring-opening Silorane chemistry which is a totally new class of compounds for use in dentistry[3]

Although the physical and mechanical properties of composite resins are indicators that predict the behavior of composite restorations, other aspects, such as material biodegradation, must be taken into account in the clinical performance of this type of restorative procedure. The critical oral environment conditions, i.e., PH changes and humidity, may increase resin composite degradation over time [4] **.**The buffering system of saliva has an important role in preventing major PH changes in the mouth environment**.** Acid erosion has clinical significance, because acidic conditions can occurred orally either due to the ingestion of acidic foods or the degradation of polysaccharides to acids in stagnant areas of the mouth .[5]

This in vitro study was designed to simulate the washing effect of saliva and the individual drinking of yogurt drink by cyclic specimen immersion, and to evaluate the influence of yogurt drinks on the surface degradation of composite in by measuring the surface microhardness.

Materials and Method

Forty samples of composite were prepared by using cylindrical mold (2mm in hight and 8mm in diameter).The molds were placed on a transparent celluloid strip which was fixed on a glass slab .The composite materials were inserted and pressed into the molds until they were overfilled, the material covered with another celluloid strip and a glass microscopic slide .100 g weight was applied to expel excess material from the mold [6] .specimen was light-cured according to the manufacturer instructions for forty seconds using light curing unit (cotloux 50,Switzerland).All specimens were stored in plastic container that contain distilled water and incubated (Fisher Scientific memert,Germany) at 37cº for 24 hours before they were tested. twenty samples of each type of composite were divided into two groups (10) for each, baseline measurements for surface microhardness test (Vichers hardness tester) was taken for all composite samples before immersion in drinking yogurt

Which were performed using Vickers hardness by using micromet microhardness tester (micro indentation test).In this study surface microhardness was measured using the micromet microhardness tester with a l00g load [7] which applied for 15 seconds in which three indentations were made for each sample and converted into Vickers Hardness

Number (VHN); the indentation were positioned to cover most of the specimen surface by equal placement over a half circle which result in wider spaced indentation and not closer than 1mm to the adjacent ones or to the margin of the specimen, the average of three measurements were calculated and obtained as one reading. After indentation was made on the composite sample surface, the length of the two diagonals of the resulting indentation were measured; using a calibrated eyepiece that reads in microns and the average of the two diagonals was recorded.

After baseline measurement 10 samples of each type of composite were alternately immersed manually by holding the specimen by apair of tweezers from its sides, in drinking yogurt (Activia, KSA) and artificial saliva for 10 cycles ,5 seconds each at room temperature (25c^{o}) this was repeated three times a day (8am,4pm,12am) at 8hours intervals for one week. Because during consumption, the drinks contact only shortly with the tooth surface before it's washed away by saliva, the other 10 samples for each type of composite were immersed in artificial saliva only the total soaking time in both drinking yogurt and saliva was 100 seconds. After the soaking sequence was completed the specimen was rinsed with distilled water and subjected to surface microhardness test (Vichers hardness tester), [8].

The artificial saliva was prepared manually with the assistance of a specialized chemist.

Composition: 2.2g/L gastric mucin, 0.38lg/L sodium chloride,0.738g/L potassium phosphate, 1.114g/L potassium chloride, 0.02% sodium azide, trace of sodium hydroxide to reach (pH 7.0) [8].

The acidity of drinking yogurt was measured with a PH meter (model 3320).The pH meter was calibrated using test solutions of known pH (Fisher Scientific International, Loughborough, UK) and it was found To be (4.6).

The titratable acidity is the amount of alkali (base) needed to be added to an acid to bring it up to a neutral PH. It therefore represents the amount of available acid and is an indication of the strength and thus of erosive potential. [9] .THE neutralisable acidity of drinking yogurt was tested by placing 20 mls of the yogurt in a glass beaker placed in a thermostatically controlled water bath held at 37°C. 0.04M sodium hydroxide solution was gradually added to the yogurt sample and the pH rise was continuously monitored until the PH increased to neutrality. sample was stirred continuously as the solution of sodium hydroxide was added. The volume of sodium hydroxide required to increase the pH of the sample to neutrality was (17.5mls); this was repeated five times.

Results

In this study, Descriptive statistics (mean values and standard deviations with the minimum and maximum values (tables1,2) and Statistical analysis of data for all groups before and after immersion using student t - test (table3) were carried out using statistical package of social science version(12) .The results showed a significant reduction in VHN values (at$P<0.05$)of Filtek™ Z350 Posterior Restorative composites after immersion in artificial saliva, while the (Filtek™ Z350 Posterior Restorative, 3M ESPE) composite showed a highly significant reduction in VHN values (at $P<0.01$)after immersion in drinking yogurt.And Filtek™ P90 Low Shrink Posterior Restorative composites showed a non significant reduction in VHN values (at$P>0.05$) after immersion in artificial saliva and after immersion in drinking yogurt.

Discussion

The widespread use of resin-based restorative materials and their exposure to the harsh conditions of the oral environment require them to be resistant to degradation. However, under acidic conditions, restorative materials, including the composite resins may suffer degradation over time, which can be predicted by changes in topography and roughness, decrease in hardness and wear resistance and substance loss ,all these shortcomings will decrease the material's physical-mechanical properties[4] .

There has been a continuing increase in soft drinks and beverages consumption among adolescents globally [10]. Which has raised a concern about the health effects of soft drinks and beverages. They are sugar-containing drinks that can be cariogenic and their low pH can cause erosion.

In general, there are two methods to quantify the acid content of a drink, these are, the PH and the titratable acid. The PH is a measure of the hydrogen ion concentration, while titrable acid (TA) is the total number of acid molecules and it determines the actual hydrogen ion availability for interaction with the tooth surface[11].

Beverages with lower PH values generally have greater erosive effects on tooth structure; however, some workers have suggested that the total acid level be considered as more important than PH level[12],

The greater the titrable acid, the longer time it will take for saliva to restore the pH value (salivary clearance) [13].

Other factors involved with surface dissolution and clinical erosion include the chelating properties of the beverage ingredients, exposure frequency, duration of the exposure and temperature [14].

The results from the present study indicate that all the yogurt drinks evaluated have PH on opening below the critical PH of dissolution (5.5). Also, they need the more base to raise their PH to neutral pH more, variously suggested to possess considerable erosive potential.

Yogurt or dairy products with low PH values produced by adding a "starter" of active yogurt containing a mixed culture of Lactobacillus bulgaricus (or occasionally L. acidophilus) and Streptococcus thermophilus. These produce lactic acid during fermentation of lactose which lowers the PH.

The investigations of drinking yogurt effect on the microhardness of composite restorative materials are important to initiate improvement in the formulation of these materials and also to upgrade the quality and longevity of the resulting restorations.

During consumption, food or drinks contact only shortly with the tooth surfaces before it's washed away by saliva. In this study the baseline microhardness mean values (VHN) for (Filtek™ P90 Low Shrink Posterior Restorative, 3M ESPE.USA) composite resin ranged from (14.4-33.3) and for (Filtek™ Z350 Posterior Restorative, 3M ESPE.USA) ranged from (9.3-24.3)

As we can see from the above mean values (VHN) of the two types of composites, the (Filtek™ P90 Low Shrink Posterior Restorative, 3M ESPE) composite had higher VHN values higher microhardness than(Filtek™ Z350 Posterior Restorative, 3M ESPE)composite , which could be attributed to the size and volume of the filler particles, (Filtek™ P90 Low Shrink Posterior

Restorative, 3M ESPE) restorative is filled with a combination of fine quartz particles and radiopaque yttrium fluoride. From the filler side, Filtek P90 restorative is to be classified as a microhybrid composite.The quartz surface is modified with a silane layer which was specifically matched to the silorane technology in order to provide the proper interface of the filler to the resin for long-term,excellent mechanical properties,while zirconia/silica filler was used in(Filtek™ Z350 Posterior Restorative, 3M ESPE), nanocomposite contains a unique combination of individual nanoparticles 20 nm in size,related to size and volume of filler particles, with increasing of filler size and volume particles exhibited higher surface hardness.

Most restorative resin materials are expected to demonstrate partial surface alterations upon immersion in an aqueous environment[15],

Filtek™ Z350 Posterior Restorative composites tested in this study showed a significant reduction in VHN values (at$P<0.05$) after immersion in artificial saliva, although there is a very little reduction in VHN values as shown in (table1),Filtek™ P90 Low Shrink Posterior Restorative composites tested in this study showed a non significant reduction in VHN values (at$P>0.05$) after immersion in artificial saliva, although there is a very little reduction in VHN values as shown in (table2), Water that can infiltrate and decrease the mechanical properties of the polymer matrix, by swelling and reducing the factional forces between the polymer chains, Similar results were obtained with artificial saliva solutions. Composite resins generally contain more organic matrix and thus may be more susceptible to water absorption and subsequent surface disintegration in an aqueous environment.

In present study the (Filtek™ P90 Low Shrink Posterior Restorative, 3M ESPE)composite resin VHN values showed a nonsignificant reduction in VHN values (at$P>0.05$) after immersion in drinking yogurt, while the (Filtek™ Z350 Posterior Restorative, 3M ESPE) composite showed a highly significant reduction in VHN values (at $P<0.01$) after immersion in drinking yogurt.

These results can be attributed to (1) the volume and size of composite filler particles as discussed before in baseline VHN values. (2)Another explanation for this reduction in VHN values may be attributed to the water absorption and hydrolytic effect of the Bis-GMA, The extent of softening of Bis-GMA copolymer depends on the soaking chemicals, the incorporation of TEGDMA in (Filtek™ Z350 Posterior Restorative, 3M ESPE)composite resulted in an increase in water uptake in Bis-GMA. Hydrophilic groups such as the ethoxy group in TEGDMA are thought to show affinity with water molecule by hydrogen bonding to oxygen. While in (Filtek™ P90 Low Shrink Posterior Restorative, 3M ESPE) the silorane matrix is Hydrophobic matrix these results agree with the findings of Fulya Toksoy Topcu, etal (2009) [16] and Kim KH etal (2002) [5], who found that the microhardness decrease related to the structure of the resin matrix.

The surface properties of a composite resin material, especially microhardness may be greatly affected by the general chemical composition of the beverages, the type of acid present in their formulation, and also the potency of the individual acidic ingredients. In the present study, the larger decrease as observed in microhardness of the composite resin specimens immersed in drinking yogurt, could be explained by the possible synergistic softening effect on Bis-GMA copolymer by the lactic acid present in yogurt. The results of this study revealed that the drinking yogurt need (17.5ml) of alkali (base) to neutralize the pH, So according to the above results the buffering capacity and titratable acidity represents the amount of available acid and is an indication of strength and thus of erosive potential.

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Table (1) descriptive statistics of Z350 composite resin (saliva, yogurt)

	Z350saliva		**Z350yogurt**	
	before	**after**	**before**	**after**
Mean	25,61	18,61	22,304	12,966
SD	2,955	4,986	3,1261	2,633
SE	0,934	1,577	0,988	0,832

Table(2): Descriptive statistics of P90 composite resin (saliva, yogurt)

	P90saliva		**P90yogurt**	
	before	**after**	**before**	**after**
Mean	16,322	13,178	14,698	13,473
SD	5,031	6,150	3,235	4,316
SE	1,591	1,945	1,023	1,365

Table(3) t-test between composites groups before & after immersion

	t-test	**P-value**	**Sig**
Z350 before and after immersion in saliva	3.82	0.0019	S*
Z350 before and after immersion in yogurt	7.22	0.000	HS**
P90 before and after immersion in saliva	1.25	0.23	NS***
P90 before and after immersion in yogurt	0.72	0.48	NS***

*P<0.05 Significant
**P<0.01 High significant
***P>0.05 Non significant