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Original Research Article

Effect of Dietary Drinks on the Microhardness of Two Nanocomposites: An in-Vitro Study

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Abstract: The aim is to determine the effect of two dietary drinks Coca Cola and Tropicana orange juice on the surface hardness of two aesthetic nanocomposite materials. Materials and methods: The materials included nanocomposite materials Shofu Beautifil II and Estelite α- supranano composite. A sample size of 120 specimens of 5.5mm × 3 mm in dimension of each restorative material was prepared . The discs were divided into 2 groups of 60 specimens each and each subgroup of 20 samples each .The discs were immersed in different beverages in time intervals of 1 hour,1 day and 1week . Surface hardness tests were performed before immersion and at time intervals of 1 hour,1 day and 1 week intervals. Statistical analysis used was one way ANOVA. Results: Exposure to Coca Cola and Tropicana orange juice reduced the hardness of both the nanocomposites with Coca Cola showing greater reduction in hardness between the two with $p<0.05$. Shofu Beautifil II showed greater reduction in hardness than Estelite α-supranano at all time intervals. Conclusion: Estelite α-supranano showed better results compared to Shofu Beautifil II .Clinicians should therefore judiciously decide which material will be better for patients taking into consideration their dietary habits and lifestyle.
Keywords: Nanocomposites, beverages, immersion, hardness.

INTRODUCTION

Aesthetic considerations dictate that the restorative materials used to restore tooth defects should approximate the natural tooth in appearance and be able to withstand biodegradation. Frequent consumption of dietary drinks in younger age groups make them more prone to dental erosion.

Acids contained in the fruit juices attack the tooth surfaces and minerals are leached out from the tooth . Dental erosion is the physical result of a pathologic, chronic, localised loss of dental hard tissue that is chemically etched away from the tooth surface by acid or chelation without bacterial involvement[1].

The early signs of enamel erosion appear as a smooth silky-shining glazed surface with the absence of perikymata. In the more advanced stages, further changes in the morphology can be found resulting in further flattening of the surface or developing a concavity in enamel, the width of which clearly exceeds its depth.

Physical factors involved in the degradation includes abrasion, attrition and erosion. Resistance to erosive by acids is an important criteria while considering selection of any restorative material.

Dental composites are considered the best material of choice for treating erosive lesions as they can seal tooth enamel and decrease further loss of tooth surface by acid exposure. In the present study two newly introduced nanocomposite restorative materials were tested to evaluate their resistance to erosion by dietary drinks.

Nanocomposites correspond to a class of new materials with nanoscale inorganic filler particles dispersed within the resinous matrix . Shofu Beautifil II which uses multi-functional glass filler with surface pre–reacted resin glass filler (S-PRG) technology based

on fluoroboroaluminosilicate glass . Estelite α-supranano composite is a newly introduced supranano composite based on the sol-gel method that controls the diameter of the fillers and changes the refractive index of the fillers .

Durability of restorative materials is the resistance to dissolution or disintegration. The resin matrix of these composites can be leached out when composites are exposed to certain chemicals or beverages as in this study[2]. Clinicians should have a knowledge of the durability of the aesthetic materials in oral cavity which is mostly affected by the routine dietary beverages that is used.

OBJECTIVES

To examine the effect of Coca Cola and Tropicana orange juice on the microhardness of two nanocomposites –Shofu Beautifil II and Estelite- α at different time intervals of 1 hour,1 day and 1 week .

MATERIALS AND METHODS

Two resin nanocomposite restorative materials and three beverages was used for the study.
Nano-Composites used were:
Group1 - Shofu Beautifil II nanocomposite (Shofu Inc Kyoto Japan)
Group II - Estelite α -supra -nano composite (Tokuyama, Taitou, Tokyo Japan)

Table 1: Composition of Nanocomposites:

Material	Specification	Composition			Manufacturer
		Polymeric Matrix	Filler type and load	Particle Size	
Shofu Beautifil II	Nanohybrid	BisGMA TEGDMA	Multifunctional glass surface pre –reacted glass filler based on fluoroboroaluminosilicate glass(68.6%)	0.8µm	Shofu Inc.Kyoto Japan
Estelite α	Supra-nano composite	BisGMA TEGDMA	Silica-Zirconia (82%)	0.1-0.3µm	Tokuyama ,Taitou,Tokyo Japan

METHODOLOGY

Fabrication of moulds: A total of 120 specimens were prepared using a plastic mould. Each mould was placed on microscopic glass slide (Labtech microglass industries) and the mould space was filled with resin composite . 60 specimens were restored with Group I :Shofu Beautifil II and 60 were restored with Group II : Estelite α-supranano composite.

After filling the mould space another glass slide was used to pack the composite inside the mould and gently pressed for 30 seconds to extrude the excess material to obtain a smooth surface. Each specimen was cured for 40 seconds from top and bottom using visible light curing unit(Blue phase –Ivoclar Vivadent) .

In each subgroup 20 prepared specimens were then immersed in the respective beverages-Deionised water, Coca Cola and Tropicana orange juice .
Subgroup 1:Deionised water(pH 6.8)
Subgroup 2:Coca Cola (pH 2.5)
Subgroup 3:Tropicana orange juice(pH 3.8)

Composition of Beverages :
Coca Cola:
Carbonated water
Sucrose
Caramel colour
Phosphoric acid
Natural flavours
Caffeine
Acidity regulator

Tropicana orange juice

Vitamin C	11.1 mg
Riboflavin	0.02mg
Citric acid	14 $mmol^{-1}$
Calcium	10 mg
Magnesium	9 mg
Phosphorus	13.9 mg
Potassium	178.5 mg
Sodium	4.6 mg

The pH of the beverages were measured using digital pH meter.The beverages were replaced each day to maintain pH and kept for 7 days. The specimens were then immersed in the respective beverages . Post immersion hardness values after immersion in storage media were calculated at 1hour, 1 day and 1 week using Vickers microhardness tester.

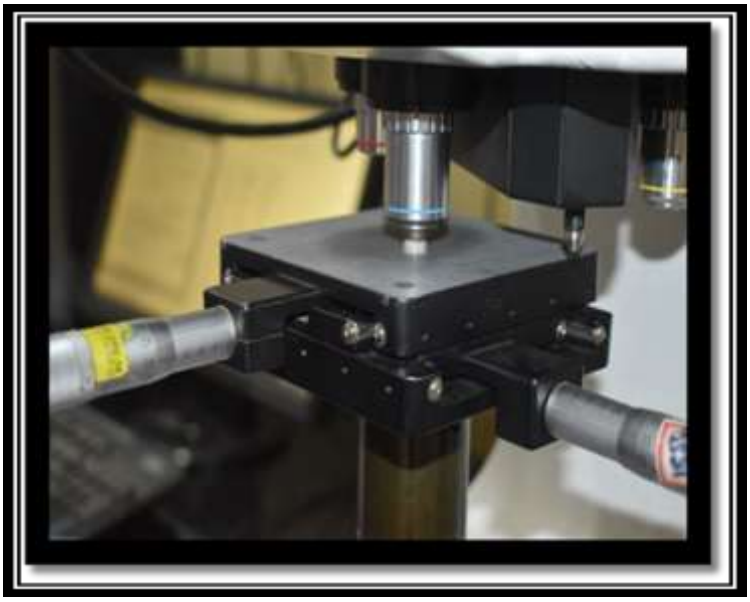

Fig-1: Microhardness testing

Statistical Analysis

The microhardness values obtained at different time intervals were statistically analysed using one way ANOVA test.

p value < 0.05 was considered for statistical significance .

The statistical software used was Minitab software version 14 .

RESULTS

Table 2: Comparison of the microhardness values of Group I (Shofu Beautifil II) after immersion in the respective beverages for various time intervals.

Group I	Subgroup	Baseline	1 hour	1 day	1 week	N	p value	Inference (p<0.05)
Shofu Beautifil II	Deionised water	33.33 ± 5.10	32 ± 4.91	31±4.79	29±4.40	20	0.019	Significant
	Coca cola	34 ± 4.68	33±4.95	24±4.95	16.67±2.88	20	0.00	Significant
	Orange juice	34.33±4.91	30.33±4.82	26.33±4.94	22±3.50	20	0.00	Significant

Table 3: Comparison of the hardness values in Group II (Estelite α-supranano after immersion in the respective beverages at various time intervals.)

Group II	Subgroup	Baseline	1 hour	1 day	1 week	N	P value	Inference (p<0.05)
Estelite α supranano	Deionised water	44.67±1.30	43.67±1.30	42.67±1.27	41±1.36	20	0.00	Significant
	Coca Cola	43.33±1.14	41.67±1.64	38.33±2.16	25.33±1.33	20	0.00	Significant
	Orange juice	45±1.54	41.33±1.76	37.67±1.97	29±2.62	20	0.00	Significant

- Exposure to Coca Cola ,orange juice and deionised water reduced the hardness of both the nanocomposites . Coca Cola showed greatest reduction in hardness followed by Tropicana orange juice and deionized water all of which were statistically significant .
- In all the subgroups of both groups greater reduction in hardness value was seen with increase in immersion time.
- When group I and group II were compared Group I showed greater decrease in hardness in all the subgroups which showed statistical significance .

Table 4: Comparison of the hardness values between the subgroups of Group I and Group II

Beverage	Group	Baseline	1hour	1 day	1 week
Deionised water	Group I	33.33±5.10	32 ± 4.91	31 ± 4.79	29±4.40
	Group II	44.67±1.30	43.67±1.30	42.67±1.27	41±1.36
	P value	0.005	0.003	0.004	0.001
	Inference	Significant	Significant	Significant	Significant
Coca Cola	Group I	32 ± 4.68	33±4.95	24 ± 4.95	16.67±2.88
	Group II	43.33±1.14	41.67±1.64	38.33±2.16	25.33±1.33
	P value	0.004	0.003	0.001	0.001
	Inference	Significant	Significant	Significant	Significant
Tropicana orange juice	Group I	34.33±4.91	30.33±4.82	26.33±4.94	22±3.50
	Group II	45±1.54	41.33±1.76	37.67±1.97	29±2.62
	P value	0.004	0.017	0.008	0.306
	Inference	Significant	Significant	Significant	Not Significant

DISCUSSION

Restorative materials in the oral cavity are usually exposed to adverse conditions like dental erosion predominantly due to extensive exposure to dietary acidic foods and drinks . Earlier reports have shown Coca Cola has affected the integrity of enamel surface. Hence it is evident that aesthetic restorative resins with mechanical properties inferior to enamel will exhibit higher vulnerability to acidic beverages.

The results of the present study showed that in both the groups highest decrease in microhardness was seen when immersed in Coca Cola (2.5 pH). This was followed by Tropicana orange juice (3.8 pH)and least decrease in hardness was seen with deionised water(6.98 pH).

These findings suggests that low pH due to the presence of acids like phosphoric acid , citric acid and other acids present in the beverages used softened the restorative material and decreased its microhardness . The result of this study is in agreement with earlier studies which have shown similar decrease in hardness of aesthetic material following exposure to beverages with low pH [2-4].

The higher decrease in microhardness with Coca Cola could be related to its acidic pH of 2.5

resulting from the presence of phosphoric acid in it . Low pH brings about a decrease in microhardness of the aesthetic restorative resin due to the following reasons :

1)By hydrolysis of the ester groups present in the BisGMA and TEGDMA and forming alcohol that may have resulted in the degradation of composite resins .

2)The erosion in the surface of filler accelerating its debonding or by increasing the release of ions from its surface .

Orange juice (pH 3.8) also showed statistically significant decrease in hardness of both the aesthetic restorative resin tested. Tropicana Orange juice contains Citric acid 14 $mmol^{-1}$ and folic acid 14.5 mcg in it. Citric acid is known for its erosive activity . Similar results of decrease in microhardness of aesthetic restorative resins and tooth enamel following exposure to beverages containing citric acid was seen in other studies [1,5].

Deionised water (pH 6.98) having a pH close to neutral showed the least decrease in microhardness however the decrease was statistically significant.

The various time intervals of 1 hour, 1 day and 1 week was taken keeping in mind two factors:

1. The post irradiation hardening of composite .
2. Restorative materials in the oral cavity may be either exposed for a short duration or longer duration to dietary acids following consumption of beverages . Shorter duration exposure occurs following consumption of dietary drinks until teeth is cleaned. Longer exposure or continuous exposure occurs when the beverages are absorbed by calculus or food particles[6].

Higher decrease in microhardness was seen with increase in immersion time . This may be because the detrimental effect of low pH beverages may not have been fully manifested during shorter immersion time.

Among the two groups Estelite α supranano composite showed better results than Shofu Beautifil II . This can be attributed to following reasons: (1)Supra nanocomposite has a higher filler loading of 82 % by weight in comparison to Shofu Beautifil II which has a filler content of 68.6% by weight . Increased filler loading has shown to result in lower water absorption, thus leading to less surface degradation.

Previous studies which evaluated the influence of filler content of the composite resins on different properties showed that the filler content seems to be the most important factor in improving the mechanical properties such as hardness, tensile strength, compressive strength and resistance to fracture.

The filler particle size is 0.2 μm in supra nanocomposite in comparison to Shofu Beautifil II where the filler particle size is 0.8 μm . The smaller filler particle size results in lesser amount of water absorbed by the polymer network, which results in lower degradation of the interface matrix / filler particle.

Estelite is manufactured using sol gel technology which controls the diameter of the filler particles. The superior mechanical properties could be due to the unique manufacturing technique used. The results of the present study is in agreement with the data provided by the manufacturers of the material, which also shows superior mechanical properties compared to other nanofilled resin composite.

CONCLUSIONS

Within the limits of this study the following conclusions were drawn:

1.This study suggests that decrease in hardness of resin restorative material was greatly influenced by the pH of the beverage . Lower the pH of the beverage greater the reduction in hardness.

2.Decrease in hardness of the restorative material was the result of the pH and the chemical composition of the beverage used. Coca Cola contained phosphoric acid whereas Tropicana orange juice has citric acid and malic acid. Each acid behaves in a different manner in softening the restorative material and hence decreasing its hardness.

3.Another finding was that the resistance to degradation of the nanocomposite by acidic beverages was also dependent on the composition of the restorative material.

4.Regular consumption of acidic beverages like Coca Cola and Tropicana orange juice decreased the microhardness of Shofu Beautifil II and Estelite α-supranano composite tested .The decrease in hardness was higher following longer and more frequent exposure .

5.Clinicians should take into consideration the dietary habits of the younger age groups before selecting the resin restorative material to be used to ensure adequate durability and aesthetics.

REFERENCES

1. Lussi, A., Jaeggi, T., & Zero, D. (2003). The Role of Diet in the Aetiology of Dental Erosion. *Caries Research, 38*(1), 34-44.
2. Hamouda, I. M. (2011). Effects of Various Beverages on Hardness, Roughness, and Solubility of Esthetic Restorative Materials. *Journal of Esthetic and Restorative Dentistry, 23*(5), 315-322.

3. Mckenzie, M. (2003). The physical properties of conventional and resin-modified glass-ionomer dental cements stored in saliva, proprietary acidic beverages, saline and water. *Biomaterials, 24*(22), 4063-4069.
4. Aliping-Mckenzie, M., Linden, R. W., & Nicholson, J. W. (2004). The effect of Coca-Cola and fruit juices on the surface hardness of glass-ionomers and compomers. *Journal of Oral Rehabilitation, 31*(11), 1046-1052.
5. Thomas A. E. (1957). Further observations on the influence of citrus fruits on human teeth.*New York State Dental Journal, 23,* 424-30.
6. Yap, A. U., Tan, S. H., Wee, S. S., Lee, C. W., Lim, E. L., & Zeng, K. Y. (2001). Chemical degradation of composite restoratives. *Journal of Oral Rehabilitation, 28*(11), 1015-1021.
7. Fatima, N., Abidi, S. Y., Qazi, F., & Jat, S. A. (2013). Effect of different tetra pack juices on microhardness of direct tooth colored-restorative materials. *The Saudi Dental Journal, 25*(1), 29-32.
8. Chanothai, H., Boonlert, K., & Ureporn, K. L. (2011). Effect of naturally acidic agents on microhardness and surface micromorphology of restorative materials. *European Journal of Dentistry, 5*, 89-100.
9. Nicholson, J. W., Gjorgievska, E., Bajraktarova, B., & Mckenzie, M. A. (2003). Changes in properties of polyacid-modified composite resins (compomers) following storage in acidic solutions. *Journal of Oral Rehabilitation, 30*(6), 601-607.
10. Turssi, C. P., Hara, A. T., Serra, M. C., & Rodrigues, A. L. (2002). Effect of storage media upon the surface micromorphology of resin-based restorative materials. *Journal of Oral Rehabilitation, 29*(9), 864-871.
11. Chadwick, R., Mccabe, J., Walls, A., & Storer, R. (1990). The effect of storage media upon the surface microhardness and abrasion resistance of three composites. *Dental Materials, 6*(2), 123-128.