ORIGINAL RESEARCH PAPER

Endodontic

KEY WORDS: Micro Hybrid Composite, Nanohybrid Composites, Surface Roughness, Profilometer

ANALYZING THE EFFECT OF FOUR DIFFERENT BEVERAGES ON SURFACE ROUGHNESS OF TWO DIFFERENT TYPES OF RESIN COMPOSITES AT DIFFERENT TIME INTERVALS: AN IN VITRO STUDY

Dr. Surabhi M Bhosale — Department Of Conservative Dentistry And Endodontics, Bharati Vidyapeeth Deemed University, Dental College And Hospital, Pune, India.

Dr. Anupam Sharma* — Professor And Head Department Of Conservative Dentistry And Endodontics, Bharati Vidyapeeth Deemed University, Dental College And Hospital, Pune, India. *Corresponding Author

Dr. Jyoti Mandlik — Professor Department Of Conservative Dentistry And Endodontics, Bharati Vidyapeeth Deemed University, Dental College And Hospital, Pune, India.

Dr. Nitin Shah — Professor Department Of Conservative Dentistry And Endodontics, Bharati Vidyapeeth Deemed University, Dental College And Hospital, Pune, India.

ABSTRACT

AIM: The aim of this in vitro study was to analyze the effect of four beverages on surface roughness of two different types of resin composites (nano-hybrid and micro-hybrid) at different time intervals.

METHODOLOGY: Eighty disc-shaped samples (8 mm×3 mm) were prepared using a custom made stainless steel mould. After 24 hours of storage, the samples were blotted dry using tissue paper and the preoperative readings for surface roughness (Ra) were obtained using profilometer. The samples were divided into two groups for the two composites [micro-hybrid (Group 1) and nano-hybrid (Group 2) n=40]. Forty discs of each material were again randomly divided into four subgroups, according to the four beverages used Coca-Cola, pH=1.57; Tea; Nimbooz, pH=2.32 and Whiskey (n=10). The samples in each group were immersed in the respective beverage for 10 minutes twice every day with a gap of 12hours. For the remaining part of the day, the samples were kept immersed in municipal water. This regimen was followed for 30 days. After 3o days the surface roughness was evaluated using same techniques as before immersion in the beverages.

RESULTS: Surface roughness of Micro hybrid composite resin was significantly increased after immersion in Coca-Cola($p<0.001$) Tea($p=0.016$) and Whiskey($p=0.005$) with $p\leq0.05$ whereas with Nimbooz the surface roughness was not increased significantly ($p=0.076$). In nanohybrid composites all four beverages increased the surface roughness significantly (p value for coca cola 0.010; for Tea 0.019; for Nimbooz 0.013 and for Whiskey 0.001)

INTRODUCTION

The aesthetic quality of a restoration may be as important to the mental health of the patient as the biological and technical qualities of the restoration are to his physical and dental health (1) Introduction of composite restorative materials in the 1960s marked the beginning of modern cosmetic dentistry by combining the principles of aesthetics and tooth conservation. Use of synthetic resins in restorative dentistry has markedly increased in recent years due to increased demand of aesthetics (2), improvements in formulations, and simplification of bonding procedures (3). The increasing demands for aesthetics coupled with outstanding development of adhesive dentistry has resulted in an increasingly wide spread of resin-based composites as restorative materials (4). Consumption of certain beverages may affect the degradation of composite restorations, resulting in unaesthetic external pigmentation, such as, stains. Due to its low pH, ethanol can produce erosion and alter some properties of composites, as well. Alcohol is also thought to act as a plasticizer of the polymer matrix. It is not known if the alcohol in typical alcoholic beverages has a negative effect on the wear resistance of resin composites (5). Restorations with smooth surfaces will result in better aesthetics, minimal accumulation of dental plaque, reduced marginal deterioration and better longevity, thus emphasizing the importance of surface texture of the restorative material (6). The effect of different beverages on micro-hybrid, Nano-hybrid composites is relatively less known. This knowledge is important to the practitioner for the selection of restorative material for the management of patients, where an exogenous erosive habit is under treatment. Therefore, this in vitro study was conducted to assess the effect of different beverages, on surface roughness micro-hybrid resin based composite and Nano-hybrid resin based composite.

METHODOLOGY:

Eighty disc-shaped samples (8 mm×3 mm) were prepared (forty for micro-hybrid and nano-hybrid composite material, each) using a custom made stainless steel mould. The stainless steel mould was placed on a glass slab and the composite was inserted in each cavity in a single increment using a plastic instrument for packing the resin. Flash was removed and material was finished flush with the top of the mold surface. A mylar strip and glass slide was placed on the mold and the specimen discs were light cured from both the sides for 40 seconds as instructed using a quartz tungsten halogen (QTH) Light Unit. The tip of curing light was placed on the glass slide perpendicular to the specimen surface to standardize the distance between the light source and the specimen. All the samples were stored at in an incubator at 37°C in distilled water for 24 hours for rehydration and completion of polymerization. Each Disc was finished using the diamond finishing bur in a rotary motion, for 15seconds with water coolant. This was followed by polishing with the Sof-lex polishing system as specified by the manufacturer.

PROCEDURE-

After 24 hours of storage, the samples were blotted dry using tissue paper and the preoperative readings for surface roughness (Ra) were obtained using profilometer. The diamond stylus tip of 2 μm radius was placed at the extremity of the disk-shaped sample and it traversed the surface of the disk to trace a 4.8 mm course, providing the measurement of Ra in micrometres. After initial assessment of surface roug hness eighty discs were divided into two groups for the two composites (forty for micro-hybrid and nano-hybrid each). Forty discs of each material were again randomly divided into four subgroups, according to the four beverages used (n=10) in the study as follows:

GROUP 1 (MICRO-HYBRID)

1. Group 1A : Coca-Cola (Coca-Cola Company, India).

pH=1.57
2. Group 1B :Tea (Sapat International Pvt. Ltd)
3. Group 1C :Nimbooz (Pepsi Foods Pvt. Ltd., India). pH=2.32
4. Group 1D : Royal Challenge Whiskey (United Spirits Ltd, India) pH=3.76

GROUP 2 (NANO-HYBRID)

1. Group 2A: Coca-Cola (Coca-Cola Company, India). pH=1.57
2. Group 2B:Tea (Sapat International Pvt. Ltd)
3. Group 2C:Nimbooz (Pepsi Foods Pvt. Ltd., India). pH=2.32
4. Group 2D: Royal Challenge Whiskey (United Spirits Ltd, India) pH=3.76

After baseline readings the samples were immersed in the respective beverages. The immersion regimen followed was as follows: The samples in each group were immersed in the respective beverage for 10 minutes twice every day with a gap of 12hours. For the remaining part of the day, the samples were kept immersed in municipal water. This regimen was followed for 30 days. After 3o days the surface roughness assessed using same techniques as before immersion in the beverages. The values of surface roughness obtained before and after immersion in the beverages were subjected to statistical analysis.

RESULTS:

Descriptive statistics were expressed as mean ± standard deviation (SD) for each group. The change in the surface roughness for each beverage was analyzed using paired Student't' test. Intergroup comparison of each beverage between the micro-hybrid and nano-hybrid group was done using unpaired t test. Within group comparison was done using One Way ANOVA test. In the above tests, p value less than or equal to 0.05 ($p \leq 0.05$) was taken to be statistically significant. All analyses were performed using SPSS software version 17.

It was observed that the surface roughness of microhybrid composite was increased significantly after immersion in Coca Cola, Tea and Whiskey but with Nimbooz, the difference between the surface roughness values before and after immersion was not statistically significant. (Table 1)

Table no.1: Effect of different beverages on the surface roughness of the micro-hybrid composite group

	Surface Roughness(Ra) in µm(mean ±SD)		P value (paired t test)
	Initial	After	
Coca Cola	0.35 ± 0.22	0.84 ± 0.3	**<0.001***
Tea	0.30 ± 0.17	0.60 ± 0.30	**0.016***
Nimbooz	0.35 ± 0.21	0.55 ± 0.26	0.076
Whisky	0.33 ± 0.19	0.55 ± 0.21	**0.005***

*$p \leq 0.05$ is statistically significant

It was observed that the surface roughness of Nanohybrid composite was increased significantly after immersion in Coca Cola, Tea and Whiskey and Nimbooz. (Table 2)

Table no.2: Effect of different beverages on the surface roughness of the nano-hybrid composite group

	Surface Roughness(Ra) in µm(mean ±SD)		P value (paired t test)
	Initial	After	
Coca Cola	0.33 ± 0.21	0.71 ± 0.34	**0.010***
Tea	0.30 ± 0.17	0.48 ± 0.24	**0.019***
Nimbooz	0.25 ± 0.13	0.44 ± 0.27	**0.013***
Whisky	0.25 ± 0.12	0.37 ± 0.10	**0.001***

*$p \leq 0.05$ is statistically significant.

DISCUSSION:

This in vitro study was conducted to evaluate the effect of different beverages on the surface roughness of nano-hybrid and micro-hybrid composites. Tea, Coca-Cola, Nimbooz and whiskey were selected in this study because they are very frequently consumed beverages. After baseline readings the samples were immersed in the respective beverages. The immersion regimen followed was as follows: The samples in each group were immersed in the respective beverage for 10 minutes twice every day with a gap of 12hours. For the remaining part of the day, the samples were kept immersed in municipal water to mimic the neutralizing part of saliva. This regimen was followed for 30 days. After 30 days surface roughness was assessed using same techniques as before immersion in the beverages.As most beverages are colloidal suspensions that will precipitate sediments after standing in stagnation, the staining outcome by prolonged immersion may have no resemblance to clinical realities. Hence in the present study, the specimens were exposed to the test beverages intermittently (7) to simulate oral conditions and immersion was carried out twice a day to simulate medium frequency consumption conditions.

According to the results of this study, specimens of both composites (micro-hybrid and nano-hybrid) became significantly rougher after they were subjected to the immersion regimen. The statistical analysis showed that there was statistically significant difference between the pre and post-immersion values of surface roughness for all the tested beverages and all samples showed staining of the surfaces. This can be ascribed to the capability of acid media to soften resin based restorative materials (5) We also observed that there was a correlation between both the tested parameters. The rougher the surface, the more susceptible the material was to staining.When different beverages were compared, Coca-Cola in both the composite groups had the most degrading effects on surface texture of both the composites followed by tea, Nimbooz and whiskey. All the beverages used in the study were acidic with Coca-Cola being the most acidic. Lower pH increased the erosion in polymers, thus the higher degradation that took place in Coca-Cola could be attributed to its lower pH (1.57). (5)

Bansal et al, in an in vitro study, compared the effect of diffe rent beverages on surface roughness and color stability of different composites. Their results suggested that coca cola had most degrading effect on both the composites (5). Rajvardhan K et al conducted an in vitro study to evaluate and compare the effect of carbonated drink cola, fruit juice and distilled water on different composites. They concluded that significant surface changes of the composites can take place when exposed to low pH drinks (6). Kaur N et al evaluated and compared the effect of a cola drink on surface roughness of esthetic restorative materials and they observed that Cola increased the surface roughness of all the resin based and glass ionomer based materials (8). Lamis A at al evaluated in vitro the influence of Pepsi Cola drink on the surface roughness of two composites and they concluded that the composite surfaces are significantly affected by exposure to acidic drink over time and highly filled composites with smaller particle size are significantly more resistant to acid erosion (9) Our results are in agreement with the above mentioned studies (5,6,8, 9). Under the conditions of this study specimens of both the composites presented a significant increase in surface roughness after immersion in Coca-Cola for 30days (Ra value for micro-hybrid before immersion was 0.35µm and after immersion was 0.84µm; whereas for nano-hybrid, before immersion 0.33µm and after immersion was 0.71µm) which could be considered as a process of degradation and erosion. Initially the surface of composite is very smooth and any process of erosion has a tendency to cause surface roughening as the relatively soft resin matrix is worn preferentially leaving the filler particles

protruding from the surface. As a function of time an increase in surface roughness is greatly expected due to leaching of fillers (9) It has been established that the erosive potential of an acidic solution is related to its pH, titratable acidity and buffer capacity. pH of Coca-Cola is low i.e 1.57. In addition, this soft drink has in its composition an inorganic and strong acid, phosphoric acid. Thus the association of a low pH and the presence of a strong inorganic acid could have caused a more aggressive attack on surfaces of specimens, hence leading to an increase in the surface roughness (8).

The specimens in the second group of this study were immersed in freshly prepared hot tea. All the specimens of this group for both the composites showed more surface roughness than Nimbooz and whiskey. The mean surface roughness value was lower than the specimens in coca cola group for both the composite groups (Ra value for micro-hybrid before immersion was 0.30 m and after immersion was 0.60 m; whereas for Nano-hybrid, before immersion 0.30 m and after immersion was 0.48 m).The increased surface roughness could be due to expansion of the polymer phase. Da Silva et al detected significant degradation of the resin matrix with immersion in tea and coffee. They concluded that the consumption of tea/coffee did not affect the micro-hardness of the resin matrix, but its surface roughness was altered in the analysed period (10). Our results coincide with these findings.

The specimens in the third group were immersed in Nimbooz. The mean value for the surface roughness of these samples was more than whiskey but less than Coca-Cola and tea. (Ra value for micro-hybrid before immersion was 0.35 m and after immersion was 0.55 m; whereas for nano-hybrid, before immersion 0.25 m and after immersion was 0.44 m).Nimbooz contains concentrated lemon juice, acidity regulators, salt, sugar, preservatives and colouring and flavouring agents. As it has concentrated lemon juice it is rich in citric acid. The pH of nimbooz is 2.32. Therefore, it can be speculated that the low pH (2.32) of nimbooz might have affected the surface integrity of the resin material, thereby softening the matrix and increasing the pigment absorption (3).

In the present study the whiskey group for both the composites has shown the minimum changes in surface roughness and color. The mean value of surface roughness for this group is lower than other groups. (Ra value for micro-hybrid before immersion was 0.33μm and after immersion was 0.55 m; whereas for nano-hybrid, before immersion 0.25 m and after immersion was 0.37μm). The surface roughness of specimens immersed in Coca-Cola was significantly higher than that of whiskey. This is probably due to presence of carbonic acid and higher pH of whiskey than Coca-Cola (11). Bansalet al analyzed the effect of whiskey, coca cola and Nimbooz on surface roughness of two different resin composites. They observed that higher degradation took place in Coca-Cola. However, Nimbooz showed a lower degradation than whiskey. This result could be due to alcohol content of whiskey (42.8% v/v), as solvents such as ethanol penetrate resin matrix leading to sub-superficial degra dation, expansion and inferior physical properties (5). The results of the present study are contrary to this finding when the comparison of surface roughness values of Nimbooz and whiskey are concerned.

CONCLUSION

WITHIN THE CONSTRAINTS OF THIS IN VITRO STUDY WE CONCLUDE THAT:

Micro-hybrid and Nano-hybrid composites become significantly rougher and get stained after they are exposed to different beverages.Micro-hybrid resin shows increased surface roughness than Nano-hybrid resin when exposed to the beverages. Coca Cola has more deteriorating effect for both the composites. whiskey has least effect on surface texture of both the composites as compared to other three beverages.There is obvious correlation between surface texture and tendency of staining of the composites. The rougher the surface, the more susceptible the material is to staining. It is difficult to extrapolate the results of this study to in vivo conditions. However, the results of this study can give an insight into how different resin composites may behave when exposed to different beverages, thus affecting the clinician's choice of material and the patient's control of dietary habits.

REFERENCES:

1. Anusavise, Kenneth J. Skinner's Science of Dental materials. 9th edition. 1991, W.B. Saunders publication.
2. Gupta R, Prakesh H, Shah N Jain V. A spectrophotometric evaluation of colour changes of various tooth coloured veneering materials after exposure to commonly consumed beverages. JIPS, Feb 2005; 5 (2) 72-78
3. UgurErdemir, EsraYildiza, MeltemMertErena journal of dentistry 40s (2012) e55-e63 Effects of sports drinks on color stability of nanofilled and microhybrid composites after long-term immersion.
4. Wedad Y. Awliya, Deemah J. Al-Alwani b, Eftekar S. Gashmer b, Huda B. Al-Mandil The effect of commonly used types of coffee on surface microhardness and color stability of resin-based composite restorations The Saudi Dental Journal (2010) 22, 177-181
5. Kshitij Bansal, Shashi Rashmi Acharya, VidyaSaraswathi Effect of alcoholic and non-alcoholic beverages on color stability and surface roughness of resin composites: An in vitro study. Journal of Conservative Dentistry Jul-Sep 2012 vol15 Issue 3
6. Rajavardhan K, Sankar AJS, Kumar MGM1, Kumar KR2, Pranitha K, Kishore KK Erosive Potential of Cola and Orange Fruit Juice on Tooth Colored Restorative Materials Annals of Medical and Health Sciences Research | Sep-Oct 2014 | Vol 4 | Special Issue3 |
7. R VeenaKumari, Hema Nagaraj, Kishore Siddaraju Evaluation of the Effect of Surface Polishing, Oral Beverages and Food Colorants on Color Stability and Surface Roughness of Nanocomposite Resins Journal of International Oral Health 2015; 7(7):1-8
8. Navroop Kaur Bajwa and Anuradha Pathak Change in Surface Roughness of Esthetic Restorative Materials after Exposure to Different Immersion Regimes in a Cola Drink Hindawi Publishing Corporation ISRN Dentistry Volume 2014, Article ID 353926, 6 pages.
9. Dr. Lamis A. Al-Taie, Dr. Anas FM Al-Aubaydi et al The Effect of Pepsi Cola Beverage on Surface Roughness of Two Composite Resins (In Vitro study) MDJ Vol.:7 No.:1 2010.
10. Maria Luísa de Alencar e Silva Leite, Fábia Danielle Sales da Cunha Medeiros e Silva2, SôniaSaegerMeireles, Rosângela Marques Duarte, Ana Karina Maciel Andrade The effect of drinks on color stability and surface roughness of nanocomposites European Journal of Dentistry, Vol 8 / Issue 3 / Jul-Sep 2014
11. Claudio poggio, albert daga, marco chiesa. Surface roughness of flowable resin composites eroded by acidic and alcoholic drinks. Journal of conservative dentistry. April-Jun 2012. Vol 15. Issue 2