Effect of Different Fluoridated Mouth Rinses on the Surface Characterization of Nano-filled Resin Composite Materials

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ABSTRACT

Background: The influence of recently marketed fluoridated mouth rinses on the surface roughness of the newly nano-filled composite resins has not yet been adequately investigated.

Objectives: This study aiming at evaluating the effects of different types of mouthwashes on surface roughness of different types of composite resins.

Materials and Methods: This experimental in vitro study included 3 types of mouthwashes (Colgate Plax, Listerine, and Aloe Dent) and 3 types of composite resins (Z350, Z250, and Art). Six specimens were prepared for each material in each group. All specimens were fabricated at room temperature 23°C. Pre-test measurements were recorded for all specimens in the three test groups using the profilometer after storing all specimens in distilled water for 24 hours. Post- test measurements were recorded after storing each specimen for 1 minute/day for 1 week. Means and standard deviations were calculated and the differences in means (before and after) between the tested groups were performed using Paired Sample t-test with p value <0.05 as a significant level.

Results: The pre-test means and SDs for the tested groups according to the type of mouthwash were 140.7±53.86 for group B, 159.63±44.34 for group C, and 166.55±51.16 for group D. The after-test readings were 158.42±47.63, 176.11±49.30, and 171.49±31.81 for the same group, respectively. The highest difference in means between before and after measurements was found in group B with a value of 17.73±10.82 with high significant level (P <0.001). The difference in means for group C was 16.48±8.42 which was also highly statistically significant (P <0.001). The lowest difference, however, was found between the means in group D with a value of 4.94±48.22 with no significant level (P >0.05).

Conclusion: Among the tested storage mouth rinses, Aloe Dent was found to have the least effect on surface roughness.

Keywords: Mouth rinse; Fluoridated; Composite; Nano-filled; Surface Roughness**.**

INTRODUCTION

The introduction of composite-based resin technology to restorative dentistry made a huge difference in oral health in different ways. In addition, it has been used as liner and base-bonded restorations and has the potential for tooth repair with less of use of tooth material. Composite resin has an organic binder and an inorganic filler in such a way that can induce polymerization reaction upon stimulation. Altered size and filler loading has improved the wear resistance of early composite resin restoration. Also, achieving surface smoothness for a restoration is vital for its success[(1,2)]. There are many factors cause surface roughness and hardness of the composite resin. Some factors are related to the dentists and clinical procedures and materials used and other factors are related to the patient and homecare means of the restorations [(3-6)].

Mouth rinses have been used for centuries for the purpose of providing oral health and cosmetic benefits[(7)], to prevent and control caries and periodontal diseases, and are frequently used even without professional prescription [(8)]. The formulation of these mouthwashes consists of water, antimicrobial agents, salts, and in some cases alcohol, and the different concentrations of these substances can affect the pH of mouthwashes[(9-11)]. In addition to conventional products containing alcohol, mouthwashes containing hydrogen peroxide have been marketed. However, in this case, besides hydrogen peroxide at low concentration, these mouthwashes contain alcohol in their composition. In addition, some side effects of mouth rinses have been reported on the surface roughness of the composite resinbecause it contains acidic solutions that may cause changes in the organic composition of resin composites [(12)]. In the last few years their use has attracted the curiosity of the researchers because of their ability to modify the surface of composite resins. Some studies have shown that these products with and without alcohol can affect the hardness of composite and have become a possible threat to oral health [(13)] because surface smoothness of the restoration is vital for its success [(13,14)]; and if the restoration surface is rough, it will contribute to the deposition of dental

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plaque, residues and coloring resulting in damage to the dental and periodontal tissues, decrease of the restoration brightness and increasing its susceptibility to surface damage [15]. Also, it will affect esthetics and function of restoration. These effects will play a major role in patient's satisfaction about the restorations [11].

Other studies indicated the controversy about the effect of mouth rinses on the surface roughness of composite material. A study was done to investigate the alteration of surface roughness of the nano-filled composites, caused by simulated brushing associated with the use of mouth rinses with or without alcohol. The study concluded that among the mouth rinses tested no significant influence on the surface roughness of nano-filled composites was observed although, alcohol was shown to have a direct influence on surface roughness [16]. Another in-vitro study was done to evaluate the effect of different mouthwashes on superficial roughness and Knoop hardness of two resin composites. The study concluded that those mouthwashes containing alcohol or hydrogen peroxide presented a higher potential to change the superficial roughness and hardness of the tested composites and alcohol-free mouthwashes affected the hardness and roughness of composites more than distilled water. In contrast, another study conducted by **Festccia *et al*.**[17] to evaluate the effect of mouth rinse solutions on color stability, surface roughness and microhardness of two composite resins concluded that composite changes depended on the material itself rather than the mouth rinse solution used.

Many studies have been conducted to observethe influence of finishing and polishing procedure and patients' dietary habits on the characteristics of the composite resin. However, the influence of recently marketed fluoridated mouth rinses on the surface roughness of the newly nano-filled composite resins has not yet been investigated. The aim of this study was to evaluate the effect of different fluoridated mouth rinses on the surface characterization of nano-filled composite resin material.

MATERIALS AND METHODS

Three different types of fluoridated mouthwashes were used as a storage medium in this study (Table 1). The materials selected in this study were 3 types of nano-filled composite resin materials. Selection of the materials included: material name, type of curing, shade, batch number and manufacturer (Table 2). Specimens of each material were divided into three groups according to the type of mouth wash: Group (A): Colgate; Group (B): Listerine Zero; and Group (C): Aloe Vera. Six specimens were prepared for each material in each group. Teflon moulds, measuring 6mm internal diameter by 3mm height, were used to produce the specimens (Figure 1). All specimens were fabricated at room temperature 23°C. A microscopic glass slide overlaid with separating medium was placed at each open end of Teflon mould. The technique required incremental packing of the Teflon mould and compacting with plastic filling instrument after which the resin composite was irradiated from each side according to the manufacturer of each type with LED Curing Light (3M ESPE Dental Products D-82229 Seefeld, Germany). Following the completed phases of light curing of each specimen, the Teflon moulds were carefully removed from the glass slides and finished with Astropol-P system (Ivoclar Vivadent, USA). Pre-test measurements were recorded for all specimens in the three test groups using the profilometer after storing all specimens in distilled water for 24 hours. Post- test measurements were recorded after storing each specimen for 1 minute/day for 1 week. The profilometer machine was used to assess the changes in surface roughness of the test specimens subsequent to each test run at the parameter Ra which is the arithmetical mean roughness of all the values of the R profile within the measuring length.The profilometer has the following characteristics (Figure 2): Measuring type, (VSI) (Variable Scanning Interferometry); Objective, 2.5X; Multiplier, 1.0X; Speed, 1X; Backscan, 5 um; Lengths of scan, 75um; Measurement area, X: 2.534 mm and Y: 1.901 mm; and Contour, Gt-K0 Bruker – USA.

The measurement readings were entered into MS Excel and the data after that were statistically analyzed by the SPSS software program V22. Means and standard deviations were calculated and the differences in means (before and after) between the tested groups were performed using Paired Sample t-test with p value <0.05 as a significant level.

The study was done after approval of ethical board of King Abdulaziz university.

RESULTS

The mean and standard deviation values of the data for the surface roughness parameters (R_a) for all materials according to the mouthwash group before and after one-week test are presented in Table 3. Graphical results for the surface roughness parameters (R_a) for all tested materials in each storage medium are presented in Figure3.

The pre-test means and SDs for the tested groups according to the type of mouthwash were 140.7±53.86 for group B, 159.63±44.34 for group C, and 166.55±51.16 for group D. The after-test readings were 158.42±47.63, 176.11±49.30, and 171.49±31.81 for the same group, respectively. The highest difference in means between before and after measurements was found in group B with a value of 17.73±10.82 with high significant level (P <0.001). The difference in means for group C was 16.48±8.42 which was also highly statistically significant (P <0.001). The lowest difference, however, was found between the means in group

D with a value of 4.94±48.22 with no significant level (P >0.05) (Table 3). For more details, Differences in means were calculated for the three composite resins in relation to each mouthwash. Both differences in means for Z350 and ART types in group B were statistically significant (P <0.05) while, difference in means for Z250 composite type in the same group was not significant (P =0.058). In group C, differences between means of Z250 and ART composite types were statistically significant while, no significant difference (P =0.084) was found between means of Z350 composite type in the same group. For group D, all differences between means of all three composite types were statistically not significant (P >0.05) (Table 4).

Table 1: Types of fluoridated mouthwashes were used as a storage medium in this study

No.	Storage mouthwash	Code	Batch Number
1	Colgate Plax	B	
2	Listerine zero	C	N-572640
3	Aloe Vera	D	18412

Table 2: Types of nano-filled composite resin materials used in this study

No.	Material	Manufacturer	Lot No.	Composition
1	Artiste® Nano Composite	1717 West Collins Ave Orange, CA 92867203-265-7397.	3898056	A mixture of difunctional methacrylates of PCBisGMA, BisGMA, UDMA and HDDMA; barium boro-silicate glass*, nano-particulated silica, zirconium silicate*, photoinitiator, Accelerator, stabilizer, silane and pigments. *contains a small amount of Al2O3
2	ESPE Filtek™ Z250	TetricEvoCeram D-82229 Seefeld - Germany	N252172	The inorganic loading is 60%by volume (without silane treatment) with a particlesize range of 0.01 to 3.5 µm. Filtek Z250 restorative contains BIS-GMA, UDMA, and BIS-EMA resins. A dental adhesive is used to permanently bond the restoration to tooth structure.
3	ESPE Filtek™ Z350 XT	3M ESPE Dental Products D-82229 Seefeld – Germany.	N221294	Combination of non-aggregated 4 to 11 nm zirconia filler and an aggregated zirconia/silica cluster filler (comprised of 20 nm silica and 4 to 11 nm xirconia particles). The Dentin, Enamel and Body shades have an average cluster particle size of 0.6 to 10 microns. The translucent shades have an average cluster particle size of 0.6 to 20 micronsThe inorganic filler loading is about and 72.5% by wt(55.6% by volume)for the translucent shades and 78.5% by wt (63.3% by volume) for all other shades. Filtek Z350 XT universal contains bis-GMA, UDMA, TEGDMA, PEGDMA and bis-EMA resins.

Figure 1: Specimens of the tested materials

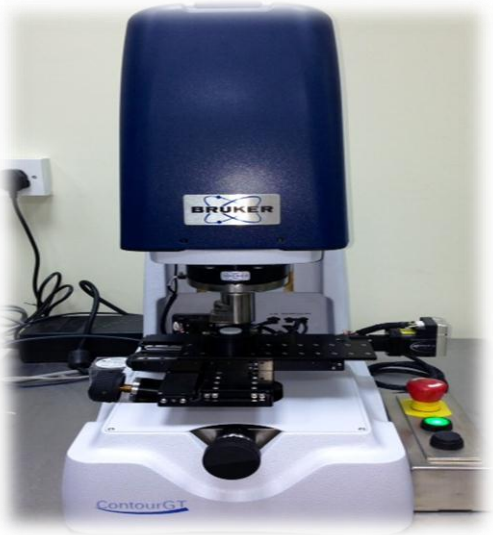

Figure 2: The profilometer machine used to assess the changes in surface roughness

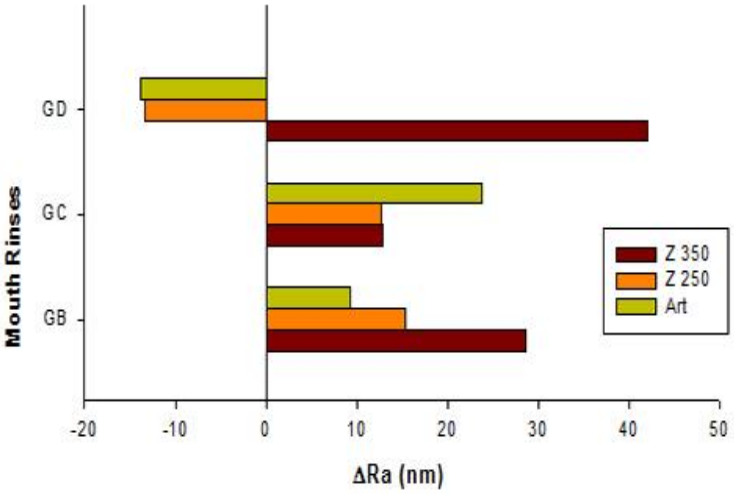

Figure 3: Graphical results for the surface roughness parameters (Ra) for all tested materials in each storage medium

Table 3: Differences in means between the different types of mouthwashes

Mouthwash	Measurement	Mean ± SD	Paired Differences			P-Value
			Mean ± SD of the Difference	95% CI of the Difference		
Group B	After	158.42 ± 47.63	17.73 ± 10.82	10.85	24.6	0.000
	Before	140.70 ± 53.86				
Group C	After	176.11 ± 49.30	16.48 ± 8.42	11.13	21.83	0.000
	Before	159.63 ± 44.34				
Group D	After	171.49 ± 31.81	4.94 ± 48.22	-25.7	35.58	0.729
		± 51.16				

Table 4: Differences in means between the different types of composites in each mouthwash group

Mouthwash	Composite	Measurement	Mean ± SD	Paired Differences			P-value
				Mean ± SD of the Difference	95% CI of the Difference		
					Lower	Upper	
Group B	Z350	After	120.36 ± 33.06	28.58 ± 7.24	17.05	40.10	.004
		Before	91.78 ± 37.34				
	Z250	After	173.83 ± 19.23	15.36 ± 10.24	-0.93	31.64	.058
		Before	158.47 ± 12.62				
	Art	After	181.09 ± 62.64	9.24 ± 3.41	3.82	14.67	.012
		Before	171.85 ± 64.63				
Group C	Z350	After	126.22 ± 24.74	12.88 ± 10.09	-3.18	28.94	.084
		Before	113.34 ± 15.51				
	Z250	After	184.57 ± 42.68	12.77 ± 5.22	4.46	21.07	.016
		Before	171.81 ± 42.08				
	Art	After	217.55 ± 27.80	23.81 ± 4.85	16.09	31.52	.002
		Before	193.75 ± 24.30				
Group D	Z350	After	156.95 ± 34.14	41.95 ± 51.43	-39.89	123.80	.201
		Before	115.00 ± 32.85				
	Z250	After	175.71 ± 44.09	-13.35 ± 23.95	-51.45	24.76	.346
		Before	189.05 ± 31.84				
	Art	After	181.82 ± 12.36	-13.78 ± 50.67	-94.41	66.85	.624
		Before	195.60 ± 46.50				

DISCUSSION

Surface roughness of the dental restoration particularly composite resins can occur due to multiple factors which can be mechanical factors including polishing and finishing, or toothbrushing or it can be chemical factors such as mouthwashes or any other liquid frequently contacting the restorations in the oral cavity. Clinically, the mouthwashes effects on resin composites may be different according to some factors, such as acquired biofilm, food habits, beverages, and oral care products, which may isolate and interfere with the physical and mechanical properties of the materials, influencing the durability of the restorative treatment, but it cannot be reproduced in vitro[3,4,6,17]The aim of this in vitro study was set to evaluate the effects of different types of commercially available mouthwashes on the surface roughness of different types of composite resins. The length of immersion time affected the Knoop micro-hardness and surface roughness of the composites tested.The PH of the tested solutions provides a possible preponderant factor for the composite matrix degradation. The

measurement of PH of Listerine and Colgate Plax mouthwashes was 3.74, while it was 4.94 for the Aloe Dent mouthwash compared to distilled water (PH= 5.5). The higher acidity may have altered the polymeric matrix of the resin composite by catalysis of ester groups from dimethacrylate monomers in mouth wash. This may have formed alcohol and carboxylic acid molecules, which accelerate the degradation of the resin composite. Analyzing the composition of mouthwashes, Colgate Plax alcohol free contains phosphoric acid and all these mouthwashes containing alcohol or hydrogen peroxide, which affect the hardness and roughness of composites more than distilled water.

In general, the results of the current study revealed significant differences when using Colgate Plax and Listerine as medium mouthwashes. These results are contrast with that found by **Urbano *et al*.**[18] in which no significant differences were detected among Plax alcohol free, Plax whitening, and Listerine mouthwashes. Another study [22] also found no significant difference when alcohol Oral B mouthwash was used. In the same study it was found that surface roughness was higher with Colgate Plax (alcohol 6%). However, there was significant change in surface roughness in the current study when Listerine mouthwash was used. This result is similar to that observed in the study of **Rocha** and his co-workers [16] where significant increase in the surface roughness was found with Listerine mouthwash. Using Aloe Dent mouthwash as an immersion medium in the present study showed no significant differences among all types of composite resins. These results are similar to that observed by **Oliveira *et al*.**[19] where no significant differences were detected when different types of fluoridated mouthwashes were used.

Some limitation of the present study should be mentioned, however. First, the effect of mouthwash on surface degradation was tested alone which is not common because the use of mouthwash is usually associated with toothbrushing. Second, the period of study was short. Finally, comparison of surface topography of the different types of composites under scanning electron microscope (SEM) was not performed. Future researches with more cycling of immersion and accompanied with toothbrushing are recommended. On the other hand, some strength points are found in this study such as using of different types of composite resins to evaluate the effects of the different used mouthwashes. Another point is the use of Aloe Dent mouthwash which has not been tested before.

CONCLUSION

Within the limitation of this study it can be concluded that surface roughness increased for the majority of the tested materials after storage in a mouth rinses depending on the type of the mouth rinse and the type of the composite resin.Among the tested storage mouth rinses, Aloe Dent was found to have the least effect on surface roughness.

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