ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
March 2025 • Vol. 37

Effect of Food Simulating Liquids and Simulated Tooth Brushing on Surface Roughness of Different Resin Composites Materials

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Aim: The study aimed to evaluate the effect of food simulating liquids with or without simulated tooth brushing on surface roughness of different resin composite materials.
Materials and Methods: Three resin composite materials (Palfique LX5, Neo Spectra ST and Brilliant Ever Glow) were used in the study. A total of 180 specimens were prepared, 60 specimens of each composite material. Each main group was divided into three subgroups (n=20) according to the three food simulating liquids (FSL) used (distilled water, methyl ethyl ketone, and 0.02 M citric acid). The specimens were immersed in each FSL for 15 days. Specimens were further subdivided into 2 groups (no brushing and simulated brushing) (n=10). Simulated tooth brushing was done in an automatic toothbrushing machine. Surface roughness was measured and data were collected, tabulated and statistically analyzed.
Results: Surface roughness of the three tested composite resin materials without brushing showed no statistically significant difference at $p \leq 0.05$ after storage in both distilled water and citric acid. MEK significantly increased the surface roughness of Brilliant everglow. After simulated tooth brushing; Neospectra recorded the highest surface roughness value in citric acid and distilled water. While, Brilliant everglow recorded the lowest surface roughness in citric acid and distilled water. MEK significantly increased the surface roughness of Neospectra and decreased that of Brilliant everglow.
Conclusion: The food simulating solutions and simulated tooth brushing altered the surface roughness of tested resin composites and these alterations are material dependent. Repolishing is recommended once per year for Neospectra and Palfique.

Keywords: Methyl ethyl ketone, Citric acid, Simulated brushing, Surface roughness, Resin composites

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Introduction

Dental composites are biomaterials frequently used in various types of tooth restorations owing to their biomechanical properties, aesthetics and ability to establish durable bonds with dental hard tissues.[1] Microhybrid composite resins provided many clinical advantages as maneuverability, mechanical strength and aesthetics. These composites are filled with inorganic micron size fillers with size of (1–5 µm) and submicron filler size of 0.4–0.8 µm, in addition to silicon particles with size of 0.04–0.05 µm. Meanwhile, recent advances in composite resin with nanosized filler particles resulted in dental composites with better clinical properties as polishability and strength together with high wear resistance and low polymerization shrinkage compared to other composite resins.[2]

Despite of the notable advances in composition of dental composites which improves its properties, but composite materials still face a lot of oral environmental challenges that affect its integrity and longevity.[3] It has been found that exposure of composite resin restorations to different foods and solutions in oral environment can cause chemical destruction and mechanical abrasion which is manifested as increased surface roughness and decreased micro hardness of such composite restorations.[4] Studies found that constituents of some foods and beverages can soften the organic phase of dental composite resins and promotes disintegration of the dispersed phase resulting in alteration of the surface properties of composite resin restorations.[5,6] Previous studies showed that surface roughness values above 0.2 µm resulted in increased plaque and oral biofilm formation.[7,8]

There are several food simulating solutions as ethanol and Methyl Ethyl Ketone which are two organic solvents with different solubility parameters, found in food and beverages and approved by the US Food and Drug Administration (FDA).[9] Furthermore, citric acid is an organic acid which simulates acids present in vegetables, fruits, candy, syrup, and beverages.[10] Some studies have assessed the effect of physiological saliva and water on resin-based composites but this is not always fully representative of the clinical situation.[11,12]

Based on previous study that investigated the changes in surface roughness, surface hardness, and solubility of four bulk-fill composites after 7- days storage in different food simulating liquids (artificial saliva, ethanol, heptane and citric acid). The study highlighted the effect of chemical composition of resin-based composite on the tested properties when stored in different chemicals. It was found that Beautiful-Bulk restorative filled with prereacted glass ionomer fillers is the most affected group in all tested materials. Regarding the effect of food simulating liquids, Citric acid and ethanol produced the highest solubility values among all of other storage media.[13] Furthermore, a study investigated the surface roughness of CAD/CAM polymer composite blocks of different filler systems at baseline,1 day and at 7 days of ageing in three food-simulating liquids: 70% ethanol/water, Methyl ethyl ketone (MEK) and water. The study results showed that all storage media adversely affected the surface roughness and hardness of each CAD/CAM composite but ageing in 70% ethanol and MEK caused more pronounced roughness and hardness changes compared to ageing in water.[14] Another study conducted by Martinez et, al. evaluated the effect of different duration of immersion (0,15 and 30 days) of various composite resin materials in different industrialized acid beverages on the surface roughness. The authors concluded that there was no statistically significant difference in surface roughness of all tested composite resin materials groups before immersion but the longer the immersion time in beverages, the more pronounced surface changes of the tested materials occurred.[15]

Furthermore, Toothbrushing with toothpaste is the most common oral hygiene habit which can induce abrasion of composite materials and in turn surface roughness.[16,17] Thus, tooth brushing is considered an important factor in assessing the clinical performance of composite materials.[18] The increase in surface roughness of either the tooth structure or composite materials results in many undesirable consequences as microorganisms' adhesion and maturation of the biofilm which results in progression of secondary caries and periodontal disease, in addition to esthetical deterioration as a result of surface staining and loss of contour.[19]

A previous study assessed the influence of various beverages; with and without brushing; on the surface roughness and microhardness of two resin composites. It concluded that acidic soft drink had the most deleterious effect while artificial saliva had the least. Furthermore, the change in surface properties was detected to be higher in the brushing subgroups.[20] On contrary, Torres et, al. conducted a study to evaluate the surface roughness and Knoop microhardness of three different composites (nanofill, nanohybrid and microfil) after 7 days immersion in chemical degradation media: artificial saliva, heptane, ethanol and citric acid followed by brushing. They concluded that brushing after chemical degradation reduced surface roughness values. In general, chemical degradation did not affect composites roughness, but microhardness was significantly reduced.[21]

So, the aim of the present study was to evaluate the effect of immersion in food simulating solutions; distilled water, citric acid and MEK with/without the abrasive action of simulated toothbrushing on the surface roughness of three composite resins. The null hypothesis of the study was that food simulating liquids with or without simulated tooth brushing have no effect on surface roughness of resin composite materials.

Materials and Methods

The materials used in this study was listed in the table 1.

Table 1: Chemical Compositions and Manufacturer details of the Tested Composite Resins

Name of brand	Specification	Composition	Shade	Manufacturer	Batch no
Palfique LX5	Submicron filled Composite resin material	Matrix: Bis-GMA and Triethylene glycol dimethacrylate. Filler Type: silica-zirconia filler and composite filler. All inorganic filler contained in PALFIQUE LX5 is a spherical submicron filler Filler Particle Size: mean particle size: 0.2 µm, particle size range: 0.1 to 0.3µm) Filler Load: 82% by weight 71% by volume	A3	Tokuyama Dental, Tokyo, Japan	286E33
Neo Spectra ST Universal Composite	Nano-Ceramic with submicron spherical filler resin Composite material	Matrix: -Methacrylate modified polysiloxane dimethacrylated resins -Ethyl4 (dimethylamino)benzoate -Bis (4-methyl phenyl) iodoniumhexafluorophosphate Filler Type: -Barium glass, prepolymerized filler and ytterbium fluoride Filler Particle Size: Spherical, pre-polymerized SphereTEC filler Filler Load: 78-80 % by weight and 60-62 % by volume	A3	Dentsply Sirona, Charlotte, NC. United States	2209000685
Brilliant EverGlow Composite	Nanohybrid resin Composite material	Matrix: bis-GMA, TEGDMA, bis-EMA Filler Type: Pre-polymerized filler containing dental glass and nano-silica, Colloidal nano-silica aggregated and non-aggregated, Barium glass Filler Particle Size: 20- 1500 nm (0.02- 1.5 µm) Filler Load: 79% by weight and 64% by volume	A3	Coltene/Whaledent AG, Altstatten, Switzerland	M15658
Methyl ethyl ketone (MEK)		Assay 99.9% M.W: 72.11g\mol Acetone 0.05% 2-Butanol 0.1% Methanol 0.05%		PIOCHEM for laboratory chemicals, Mansoura, Egypt	lot CA17500KS L13002
0.02 M Citric acid		Assay 99.5% M.W: 210.1g/mol white crystal sulphates ≤ 20ppm		PIOCHEM for laboratory chemicals, Mansoura, Egypt	lot MEK151600 LSL25004
Signal cavity fighter	Tooth paste	Calcium carbonate, water, sorbitol, hydrated silica, sodium lauryl sulfate, sodium monofluorophosphate, Aroma (flavor), cellulose gum, potassium citrate, trisodium phosphate, sodium saccharin, phenylcarbinol, glycerin, limonene.		Signal Arabia, Unilever	

Study design

Sample size calculation was performed using G*Power version 3.1.9.7. A power analysis was designed to have adequate power to apply a two-sided statistical test to reject the null hypothesis that there is no difference between groups. By adopting an alpha level of (0.05) and a beta of (0.1), i.e. power = 90% and an effect size (d) of (0.45). The predicted sample size (n) was (180) to show power of the study and appropriate results.

A total of 180 composite resin specimens were used in this study to investigate surface roughness. The specimens were divided into 3 main groups (60 specimens each) according to type of composite resin material; group 1: Palfique LX5 (Tokuyama Dental, Tokyo, Japan), group 2: Neo Spectra ST Universal Composite (Dentsply Sirona, Charlotte, NC. United States), and group 3: Brilliant EverGlow Composite (Coltene/Whaledent AG, Altstatten, Switzerland).

The specimens were prepared in disks of 2 mm height and 5mm diameter using Teflon split mold.[9] First, a Mylar strip was placed over a glass microscopic slide then the mold was placed over it. The composite resin material was placed as a single increment of 2mm thickness and covered with a Mylar strip and another glass slide. Weight of 500 g was placed over the glass slide for 1 minute to obtain a flat surface and to standardize the force applied to the surface.[20] Curing is done with hand light curing unit B-Cure LED (Guilin Woodpecker Medical instruments Co., Ltd., Guilin, Guangxi, China) with emission wavelength range of 385m - 420 nm and light output of 1200 mw/cm^2 for three seconds then the glass slide and Mylar strip was removed, and curing was continued for 10 seconds according to manufacturer instructions.[22] Light curing unit was periodically checked using a radiometer (Model 100 curing radiometer, Kerr, USA), for 20 s according to the manufacturer's instructions. The bottom surfaces of composite resin specimens were marked with a marker.

Polishing procedure

Polishing of the top surface of composite resin specimens was done using One Gloss (Shofu Inc, Kyoto, Japan) in slow speed hand- piece (W&H Alegra WE-56) rotating at a maximum of 15,000 rpm without coolant and with a constant light pressure with repetitive stroking action simulating clinical use in order to reduce the risk of scratching or grooving specimens. A new polishing disc was used for each specimen for 30 seconds and was discarded after each use.[23]

Each group was further sub-divided into 3 smaller groups according to the type of food simulating liquid used for immersion (n=20 each); subgroup1, methyl ethyl ketone, subgroup2, 0.02M citric acid and subgroup3, specimens were immersed into distilled water as control group. Then each sub group is further divided into 2 smaller groups (n=10 each) to be subjected to simulated tooth brushing or with no brushing.

Immersion

The specimens were then randomly immersed in 15 ml of each storage media in individual glass vials in an incubator (Biotech, Egypt) at a 37 ±1◦C and kept under the same conditions for 15 days (dwell time).[11] The vials were sealed to prevent evaporation of the solutions and the liquid content was renewed every 24 hours to avoid fungal contamination. Each tube was rinsed and dried before changing the beverage every day.[15] After the storage period specimens were taken out of the storage media, rinsed with distilled water and blot dried carefully against filter paper to perform roughness test.

Tooth brushing simulation

The specimens of simulated brushing groups were subjected to brushing in an automatic toothbrushing simulating machine (figure 1). This apparatus provides linear brushing movements across the specimens at a speed of 120 cycles per minute at 37°C, with a double pass of medium bristle tooth brush head over the surface (Oral B pro-expert extra clean). The top surfaces of resin composites cylinders were submitted to 10,000 brushing stokes under a vertical load of 200 gm (figure 2) with toothpaste slurry (Signal cavity fighter, Unilever), simulating 1 year of clinical situation.[21] The toothpaste slurry was made by mixing the paste with distilled water in a ratio of 1:1 by volume.[20] Toothbrushes were replaced after the completion of each brushing cycles.[21]

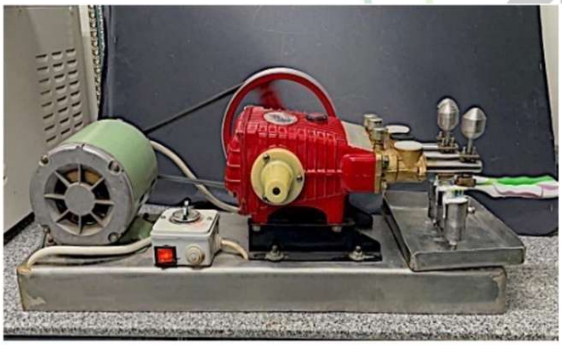

Figure 1: Automatic tooth brushing simulating machine

Figure 2: tooth brush head contacting surface of specimens during stroke under vertical load

Surface roughness analysis:

A surface profilometer (TR 220 Surface Roughness Tester, TIME Group, Pittsburgh, PA, USA) was used to measure the surface roughness, with a cut-off value of 0.25 mm. Three measurements were recorded for each specimen and an average surface roughness (Ra) was determined for each specimen.

Statistical analysis

Values (numerical data) were explored for normality by checking the data distribution, calculating the mean and median values, and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. Two and Three-way ANOVA was used to study the effect of different tested variables and their interaction. Comparison of main and simple effects were done utilizing pairwise t-tests with Bonferroni correction. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with IBM SPSS Statistics Version 26 for Windows. (®IBM Corporation, NY, USA. ®SPSS, Inc., an IBM Company).

Results

Three-way ANOVA revealed that there was statistically significant effect of food simulating liquids (P=0.001), composite resin materials (P=0.001), simulated tooth brushing (P=0.036) and their interactions (P=0.038) on surface roughness.

Regarding surface roughness of the tested resin composites after storage in different food simulating liquids without brushing

There was no statistically significant difference at $p \leq 0.05$ in surface roughness of the three tested resin composite materials used after storage in both distilled water and citric acid without brushing. On contrary, MEK significantly increased the surface roughness of brilliant everglow composite compared to surface roughness of the other two resin composites; Neospectra and Palfique which had no statistically significant difference between them.

Table 2: Three-way Anova for the Effect of different variables and their interactions on surface roughness.

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Food simulating solution	0.616	2	0.308	8.204	0.001*
Composite resin materials	0.594	2	0.297	7.907	0.001*
Simulated tooth brushing	0.474	1	0.274	3.970	0.036*
Solution × materials × tooth brushing	0.404	4	0.226	3.285	0.038*

df=degree of freedom*; significant *(p ≤0.05)* ns; non-significant *(p>0.05)*

Regarding surface roughness of tested resin composites after storage in different food simulating liquids and simulated tooth brushing

There was statistically significant difference at p≤ 0.05 in surface roughness of the three tested composite materials used after simulated tooth brushing. Neospectra recorded the highest value in citric acid and MEK but with no statistical significance between them, while it recorded the least value in distilled water. In Brilliant everglow composite, there was statistically significant difference at p≤ 0.05 between surface roughness mean values where highest surface roughness value was recorded for MEK group followed by surface roughness value in citric acid and the lowest recorded surface roughness value was in distilled water. Regarding Palfique LX5, both citric acid and MEK groups recorded high surface roughness values but with no statistically significant difference between the two groups while, it recorded the least surface roughness value with distilled water.

MEK, significantly increased surface roughness of all tested composite compared to non-brushing groups except for brilliant everglow; surface roughness decreased compared to non-brushing group but with no statistical significance. Neospectra showed the highest mean surface roughness values compared to both Palfique and Brilliant everglow composites.

Citric acid significantly increased surface roughness of all tested composite compared to non-brushing groups. Neospectra showed the highest mean surface roughness values followed by Palfique LXT and the least values were recorded for Brilliant everglow.

Table 3: Three-way ANOVA and post hoc tests for the mean ± SD values of surface roughness of different groups

Composite material	FSL	Surface roughness without simulated tooth brushing	Surface roughness After simulated tooth brushing
Palfique LX5	Distilled water (control)	0.32±0.07Aa	0.17±0.04Cb
	Citric acid	0.05±0.01Cb	0.32±0.08Ba
	MEK	0.24±0.05Ba	0.32±0.08Ba
Brilliant everglow	Distilled water (control)	0.42±0.10Aa	0.07±0.02Db
	Citric acid	0.09±0.02Cb	0.17±0.04Ca
	MEK	0.43±0.10Aa	0.27±0.07Ba
Neo spectra ST	Distilled water (control)	0.42±0.11Aa	0.28±0.06Ba
	Citric acid	0.08±0.02Cb	0.55±0.12Aa
	MEK	0.25±0.07Bb	0.45±0.10Aa

Data are expressed mean± and standard deviation
Different small letters indicate significant difference at (p<0.05) among means in the same row
Different capital letter indicates significant difference at (p<0.05) among means in the same column

Discussion

Restorative dental materials are subjected to different environmental conditions including biological, chemical, physical and mechanical during their clinical service.[14] In the oral environment, it can be assumed that saliva, food components, beverages, brushing and interactions among these factors can degrade and age dental restorations resulting in surface roughness and subsequent unesthetic appearance, in addition to wear that affects restorations longevity.[24–26] Moreover, recurrent caries and periodontal diseases occurs as a result of surface roughness that encourages plaque adhesion.[27]

According to previous studies, several qualitative and quantitative methods were used in measuring and assessing surface roughness including atomic force microscopy (AFM), two dimensional (mechanical) and three dimensional (optic) profilometer, and SEM.[28,29] In the current study, surface roughness is measured with mechanical profilometer which is the most widely used instrument in measuring surface properties of composite as it permits outstanding measurement repeatability, easy to use, more affordable than other methods, and upgradeable.[13,30]

Three different composite resin materials were used in the study owing to their esthetic qualities claimed by manufacturers. The three used composite resin materials are different in organic matrix composition and the type of filler to determine if chemical composition will affect the performance of materials under the tested variables.

The composite materials were tested for surface roughness after immersion in three different food-simulating liquids; distilled water, MEK, and citric acid with and without brushing simulation. These liquids were selected in accordance with the guidelines of the US Food and Drug Administration to mimic different foods and chemicals action on surface roughness of resin composites.[31] In the current study, water immersion simulates the wet oral environment provided by saliva; citric acid immersion simulates vegetables, fruits, and sugar; while MEK simulates fruits, yogurt, butter, fat meals and vegetable oils. Many studies in literature showed surface changes of dental composites by food-simulating liquids as a result of solubility or breaking of bonds of the polymer matrix, degradation of matrix- filler interface, and the dislodgement of inorganic filler particles.[21,29,32] Storage of composite specimens in food simulating liquids was done for 15 days at 37°C. This period of immersion was chosen to accelerate the effect of the food-simulating liquids, being in accordance to previous studies.[33,34] Von Fraunhofer et, al. assumed that "The time of dentition and subsequently restoration exposure to beverage is closer to 20 seconds before salivary clearance occurs; this would make the annual exposure of dental enamel to soft drinks approximately 90,000 seconds (that is, 1,500 minutes or 25 hours) per year. Fraunhofer adopted 15 days for the test period which is equivalent to 360 hours which is comparable to approximately 13 years of normal beverage consumption that he considered reasonable immersion time for testing surface properties of enamel dissolution.[35]

Furthermore, tooth brushing provides some superficial macroscopic and microscopic irregularities on composite materials.[16] In the current study, the effect of tooth brushing on surface roughness of composite was measured simulating the clinical situation, where brushing come just after the exposure to chemical agents.[3,20,21] The brushing simulation protocol used in the current study is equivalent to 1 year of clinical situation.[21]

The current study showed no statistically significant difference in surface roughness of the three composite resin materials tested after storage in distilled water which represented control groups. While, citric acid showed significant decrease in surface roughness of all tested composites without brushing compared to control groups (distilled water). These results were in accordance with in-vitro studies which reported that weak carboxylic acids as citric acid acts as lubricant forming a layer on restoration surface capable of reducing coefficient of friction and hence the surface roughness compared to distilled water.[36–38]

On the other hand, results of the present study contradict with that of Cabadag et, al. who reported significant increase in surface roughness of different tested material; beautiful bulk (giomer-based restorative) kept for 7 days in citric acid. This was attributed to high sensitivity of fluorosilicate fillers to decomposition by weak acids.[13] Mohamed et al. also reported that surface roughness values of nanofilled composite increased after immersion for 7 days in acidic solutions of 2.5 and 5.5 pH values respectively.[12] This differs from the present study in lack of finishing and polishing procedures of tested resin composite specimens whose surfaces were cured against polyester matrix film. Furthermore, Tanthanuch et, al. study results contradicted the present study as they concluded that acidic food-simulating liquids significantly increased the surface roughness of bulk-fill resin composites after 28-day of immersion.[39] The difference in results may be due to different acidic beverages and longer period of immersion used in their study. Previous studies stated that surface roughness has a direct relationship with duration of exposure to food simulating solutions.[13,26]

On the other hand, storage in MEK significantly increased surface roughness of all tested composite materials without brushing when compared to citric acid. This was in accordance with previous study which concluded that storage in MEK for 15 days resulted in more evident increase in surface roughness of tested resin composites compared to other liquids used in the study.[11] It was reported that when resin-based composites are stored in fluids, the resin matrices tend to absorb the fluids resulting in swelling, plasticization and subsequent microcracks in both resin matrix and resin filler interface with subsequent debonding of fillers and increase in surface roughness.[40] Furthermore, solubility parameters of MEK (19.3 δ/MPa1/2) are close to that of methacrylate monomers (18.6 δ/MPa1/2) used in composite resins resulting in increased solvent uptake and resin degradation which subsequently increases surface roughness.[9]

When comparing the effect of citric acid immersion and MEK, a previous study conducted by Albarran Martinez et al. reported that different beverages as apple juice (containing citric acid) and fermented milk (containing MEK) significantly increased surface roughness of flowable composite at 15 and 30 days but with no significant difference between the two beverages.[15]

In the present study, it was reported that simulated tooth brushing significantly increased surface roughness of both Neospectra and Palfique composite resin materials stored in citric acid compared to distilled water (control group) and significantly increased surface roughness of Neospectra stored in MEK but significantly decreased surface roughness of Brilliant everglow stored in MEK. Brushing in the current study yielded an increase in surface roughness more than in the non-brushing groups. These results were in line with Elmalawany et, al and Paolone et, al. who postulated that brushing increased roughness depending on several factors, including the chemical composition of composite resin matrix and filler particles size and distribution, brushing time, and the abrasiveness of the toothpaste.[20,41]

Neospectra ST had the highest roughness in brushing groups followed by Palfique and the least roughness recorded was Brilliant everglow. Regarding Neospectra, it was claimed by the manufacturer that it is nanoceramic composite filled with spherical particles. Results of the current study might be attributed to filler type and size. Neospectra had barium glass and prepolymerized organic fillers without any information provided by manufacturer on filler sizes. Neospectra composite had the lowest filler loading (60-62 vol%) in composites used in this study and thus showed the highest surface roughness. Findings of the current study were in agreement with previous research which demonstrated that decrease in filler loading increased surface roughness of tested nanohybrid composite under the effect of gastric acid.[42] Furthermore, previous studies reported that the decrease in the filler volume/weight loading decreases the wear resistance against the external factors and thus increase surface roughness.[43] In addition, Neospectra composite contains pre-polymerized fillers. It was reported in previous studies that pre-polymerized fillers act by two different ways to increase surface roughness. First, it demonstrates weak bonds to the organic matrix due to fewer residual double bonds with subsequent failure at filler/matrix interface. Moreover, such fillers are difficult to be silanized, and thus difficult to be integrated into the organic matrix; this increases surface roughness following simulated brushing abrasion.[44]

Brilliant everglow showed the least surface roughness values after simulated tooth brushing in all tested fluids compared to all composites tested. This may be attributed to filler particles type, size and distribution.[45] Brilliant everglow is nanohybrid composite contains fillers of size 20- 1500 nm (0.02- 1.5 µm). Furthermore, the agglomerated nanoparticles of zirconia and silica present in Brilliant everglow allow them to be worn off evenly by brushing leaving few pits on the superficial layer of composite. Moreover, it contains TEGDMA as a diluent monomer in its resin matrix which improves degree of polymerization resulting in condensed resin matrix and, thus more resistant smooth surface to degradation by food simulating liquids. Results were in agreement with previous study which compared surface roughness and microbial adhesion of alkasite resin-based composite versus bioactive giomer after simulated toothbrushing. It concluded that giomer showed less surface roughness which was attributed to small filler size and composition of fillers that delay the material diffusion in water.[46]

Thus, the null hypothesis was rejected as the various food simulating liquids with/without brushing caused a change in surface roughness of the three dental resin composites.

The most important limitation of the present study is that this is an in vitro study. Under clinical conditions, food consumption, brushing activity and temperature changes are in a continuous cycle over a 1-year period. However, in the present study, in order to simulate the 1-year clinical situation, blocks were immersed in solutions, then subjected to brushing simulation sequentially and no thermal cycling performed. Considering the limitations of the present study, more clinical long- term studies evaluating the effects of different food simulating solutions and simulated brushing techniques are needed.

Conclusion

Within the limitations of this study, the following conclusions were drawn:

1. The food simulating solutions and brushing simulation altered the surface roughness of composites, and these alterations are material dependent due to different composition of resin matrix and different filler particles in all tested composites.
2. Surface roughness of Neospectra and Palfique composites exceeded the critical threshold of 0.2 mm after simulated tooth brushing equivalent to 1 year thus repolishing is recommended once a year while, for Brilliant everglow repolishing time could be longer and needs to be further studied.

Declaration

Funding

No funding was received for this work.

Data availability

The data that support the findings of this study are available on request from the corresponding author

Competing interests

The authors declare that there is no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval

The study protocol received approval from the Council of the restorative Dentistry Department and underwent ethical review by the Research Ethics Committee of Faculty of Dentistry, Ain Shams University (Approval no. FDA SU-REC ER102417)

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