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Original article

In vitro evaluation of the effectiveness of pediatric drugs and tooth brushing on the surface roughness of different restorative dental materials used in pedodontics

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ABSTRACT

Background: *Liquid oral drugs are frequently used in children. Knowing the effects of these drugs and individual oral hygiene brushing on the surface roughness (SR) of dental restorative materials with different contents used in pediatric dentistry is clinically important.* ***Purpose:*** *The aim is to assess the effects of various drugs and toothbrushes used in children on the SR of dental restorative materials.* ***Methods:*** *A total of 60 samples of different dental filling materials (polyacid-modified composite resin [compomer], glass ionomer cement [GIC], and composite resin) were prepared. The specimens were divided into six solution groups (distilled water, antibiotics, analgesics, antiepileptics, bronchodilators, and anti-allergic drugs). For each group (n = 5), two subgroups (brushing and non-brushing) were created. Surface roughness values (Ra) were measured at baseline and at the first and fourth weeks using a profilometer. The data were analyzed using analysis of variance, post-hoc analysis, and the Bonferroni test ($p < 0.05$).* ***Results:*** *The highest roughness value among all drug groups was detected in the non-resin-containing traditional GIC material. In addition, the brushing condition had a statistically significant effect on SR values ($p < 0.05$). The smallest change in roughness from baseline to the fourth week was observed in the non-brushed composite material in the Amoklavin group, whereas the largest change was observed in the brushed GIC material in the Depakin solution.* ***Conclusion:*** *Drug solutions and brushing affect the SR of restorative materials, with resin-containing materials being less affected than GIC.*

Keywords: *dental materials; medicine; pediatric drugs; profilometer; surface roughness; tooth brushing*
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INTRODUCTION

Different restorative materials are used in pediatric dentistry depending on the need and appropriate indication. Resin-based materials (polyacid-modified composite resin [compomer] and composite resin [CR])[1] that meet patients' aesthetic concerns are widely used in clinical applications.[2,3] Additionally, glass ionomer cement (GIC)-based restorative materials, which release fluorine ions, are frequently preferred.[4,5] These restorative materials, used in dentistry in recent years, have physical and mechanical properties. Despite the development of features such as improved mouthfeel and aesthetics, negative effects may arise over time, damaging structural integrity.[6]

In laboratory studies, the surface properties of dental restorative materials can be evaluated using wear simulation, which assesses the surface properties and wear resistance, and mechanical degradation tests, which determine wear due to brushing.[7] Surface roughness (SR) significantly affects the material's color stability and long-term success.[8] An essential factor in maintaining surface quality is good surface smoothness. The SR of restorative materials is crucial for clinical success, impacting brightness, transparency, discoloration, secondary caries, plaque accumulation, and gingivitis.[9–12]

The materials must be ideally finished and polished to prevent these negative effects, ensuring proper polymerization.[13,14] Although the SR value at which bacteria will adhere is unclear, bacterial accumulation

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occurs on materials with a SR value (Ra) above 0.2 µm.[15,16] However, if the Ra value is above 0.3 µm, patients' tongues may experience discomfort, especially in pedodontics patients.[17] Many studies have investigated the effects of foods, beverages, and liquid medications on restorative materials.[18]

Children are often prescribed liquid oral medications by their physicians for the treatment of diseases.[15] These medications contain various components.[19,20] Since these drugs contain sucrose, they lower the pH of dental plaque and increase the fermentation of oral microflora, raising the incidence of dental caries.[21] The decrease in pH, combined with exposure of primary teeth to the liquids in pediatric drugs, enhances the titration of the acidic components, leading to disintegration of the restoration surface, which may cause surface changes.[22] In this study, the null hypothesis is that various pediatric drugs and brushing will not affect the SR of dental restorative materials with different compositions used in pedodontics under *in vitro* conditions. This *in vitro* study assessed the effects of various medications used in children and brushing on the SR of children's filling materials with different compositions.

MATERIALS AND METHODS

The five pediatric oral liquid medication groups commonly used in children and the properties of the three restorative materials are summarized in Tables 1 and 2. The study groups consisted of three different restorative materials: compomer (XP Dyract, Dentsply DeTrey, Seefeld, GmbH, Germany), CR (Voco Arabesk N, Voco, Cuxhaven, GmbH, Germany), and GIC (IonoStar Plus, Voco, Cuxhaven, GmbH, Germany). The three restorative materials were immersed in five drug groups (antibiotics, analgesics, antiepileptics, bronchodilators, and anti-allergic medications) daily (one minute, three times a day, eight hours apart). At the end of four weeks, SR was evaluated and compared to the baseline. The effect of brushing on SR was also examined. Figure 1 presents the study design.

Following the power analysis conducted using the G*Power program (G*Power 3.1 software; Heinrich Heine University, Düsseldorf, Germany) for the F-test analysis, it was determined that five samples for each subgroup, which were formed by dividing the 18 groups (3 materials × 6 drug groups) into two subgroups—brushed and unbrushed—were sufficient for the study. With an α (margin of error)

Table 1. Pediatric drugs used in the study

Therapeutic Class	Brand Name	Active Ingredient
Antibiotics	Amoklavin	Amoxicillin + clavulanic acid
Analgesics	Parol	Paracetamol
Antiepileptics	Depakin	Valproate sodium
Bronchodilator	Ventolin	Ventolin
Anti-allergic	Zyrtec	Cetirizine dihydrochloride

Table 2. Restorative materials used in the study

Product	Material Type	Mixing	Curing	Manufacturer
Dyract XP	Polyacid-modified composite resin (compomer)	N/A	Light: cure for 20 seconds	Dentsply DeTrey, GmbH, Germany
Voco Arabesk N	Composite resin	N/A	Light: cure for 20 seconds	Voco Cuxhaven, GmbH, Germany
IonoStar Plus	Glass ionomer cement	10 seconds with a mixer	No cure, allowed to set for 5 minutes	Voco Cuxhaven, GmbH, Germany

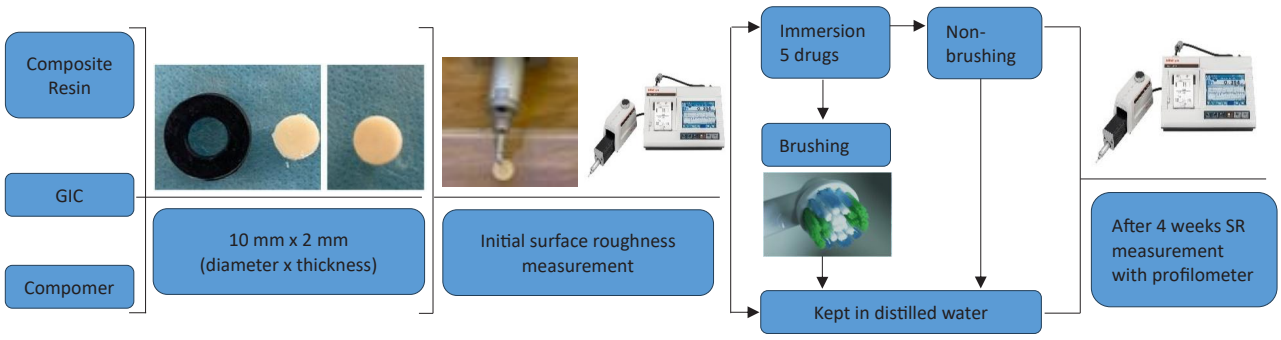

Figure 1. Study design.

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= 0.05, an effect size (f) of 0.25, and a power level (1-β) of 0.95, a total of 180 samples (five samples per subgroup) were deemed sufficient. Each material was prepared using ring molds to create 60 disc-shaped samples (10 mm diameter × 2 mm thickness) according to the manufacturer's instructions. To prevent the formation of gaps while placing the materials, a transparent matrix tape was placed on the ring, and the samples were positioned between two cement glasses, resulting in 180 restorative samples. The CR and compomer materials were polymerized by applying light to both sides separately for 20 seconds using an LED light device (Woodpecker LED.B; Guilin Woodpecker Medical Instrument Co., Guilin, China). The device was applied by contacting the surfaces of the samples.

Conventional GIC was activated and prepared in the amalgam mixer (Gnatus Amalga Mix 2) for 10 seconds according to the manufacturer's recommendations. The GIC was placed in the disk mold, and the GIC samples were chemically polymerized. All disc-shaped specimens were removed from the molds and checked for irregularities in their shapes. Irregularly shaped samples were excluded from the study.

All specimens were polished using aluminum oxide polishing disks (Sof-Lex Polishing Wheels, 3M ESPE, St. Paul, MN) under water cooling, starting from coarse to fine disks. New disks were used to polish each specimen. After polishing and finishing, the residue on the specimens was cleaned and removed under running distilled water. Samples were stored in distilled water at 37°C for 24 hours to complete the polymerization process.[23]

Samples from each restorative group were randomly placed in distilled water and divided into five drug groups and a control group. The number of samples in each group was set at 10. Additionally, the samples were further divided into two subgroups (brushing and non-brushing) within each group (n = 5). To obtain objective results, initial SR measurements were performed using a profilometer (Mitutoyo SJ-Series 410, Mitutoyo Co., Tokyo, Japan). The profilometer was calibrated after each measurement. Three separate measurements were taken from each sample, and the average was calculated. The SR value was recorded as Ra. The profilometer was set to a stylus speed of 0.5 mm/second, a measuring distance of 2.4 mm, and a cutoff value of 0.8 mm. After the first measurement, the samples were kept in distilled water at room temperature and immersed in 10 mL of the drug solution from each group for one minute, two times a day (eight hours apart). The drug solution was replaced at each immersion. This procedure was repeated for four weeks. Antibiotics were prepared weekly and stored in the refrigerator to maintain freshness.

To simulate tooth brushing, 2 mL of non-fluoride toothpaste (R.O.C.S Kids, Tallinn, Estonia) was applied to a toothbrush (Braun Oral-B Genius X) once a day. Each sample was brushed by the same person with an electric toothbrush in daily cleaning mode, using 40 brush strokes and not exceeding a standardized force of 2 N. The pressure was also controlled, thanks to the brush's visual gum pressure control feature. This process corresponds to brushing for 10 seconds when a tooth is brushed for two minutes daily.[24] After the samples were rinsed thoroughly, they were placed back in distilled water. After the samples were dried with tissue paper, the changes in SR were measured by comparing the first and fourth-week measurements to the baseline.

Table 3. Four-factor repeated measures analysis of variance results

Source	Type III Sum of Squares	df	Mean Square	F	P	Partial Eta^2
Corrected model	32.609	107	0.30	9.27	0.001*	0.697
Intercept	99.084	1	99.08	3,012.43	0.001*	0.875
Teeth brushing	0.987	1	0.99	30.00	0.001*	0.065
Material	22.962	2	11.48	349.06	0.001*	0.619
Drug	0.158	5	0.03	0.96	0.443	0.011
Time	2.868	2	1.43	43.59	0.001*	0.169
Teeth brushing * Material	0.086	2	0.04	1.31	0.272	0.006
Teeth brushing * Solution	0.409	5	0.08	2.49	0.031*	0.028
Teeth brushing * Time	0.060	2	0.03	0.92	0.401	0.004
Material * Solution	2.127	10	0.21	6.47	0.001*	0.131
Material * Time	0.959	4	0.24	7.29	0.001*	0.063
Solution * Time	0.167	10	0.02	0.51	0.884	0.012
Teeth brushing * Material * Solution	1.055	10	0.11	3.21	0.001*	0.069
Teeth brushing * Material * Time	0.015	4	0.00	0.11	0.978	0.001
Teeth brushing * Solution * Time	0.082	10	0.01	0.25	0.991	0.006
Material * Solution * Time	0.516	20	0.03	0.78	0.734	0.035
Teeth brushing * Material * Solution * Time	0.117	20	0.01	0.18	1.000	0.008
Error	14.143	430	0.03			
Total	146.359	538				
Corrected total	46.752	537				

a. $R^2 = 0.697$ (Adjusted $R^2 = 0.622$)

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Table 4. Comparison of roughness value measurements

		Compomer		Surface Roughness (Ra) Composite		Glass Ionomer Cement	
		Non-brushing	Brushing	Non-brushing	Brushing	Non-brushing	Brushing
Beginning	Distilled water	0.22 ± 0.04^{1}	$0.18 \pm 0.03^{X, 1}$	$0.20 \pm 0.05^{a, 1}$	$0.21 \pm 0.04^{X, 1}$	$0.54 \pm 0.14^{A, a, 2}$	$0.63 \pm 0.10^{X, a, 2}$
	Amoklavin	0.25 ± 0.23^{1}	$0.32 \pm 0.08^{Y, a, 1}$	0.19 ± 0.06^{1}	$0.19 \pm 0.11^{X, 2}$	$0.49 \pm 0.30^{A, a, 2*}$	$0.65 \pm 0.15^{X, a, 3*}$
	Parol	$0.26 \pm 0.04^{a, 1*}$	$0.44 \pm 0.26^{Y, a, 1*}$	0.16 ± 0.03^{1}	$0.24 \pm 0.08^{X, a, 2}$	$0.54 \pm 0.14^{A, a, 2}$	$0.49 \pm 0.16^{Y, a, 3}$
	Ventolin	$0.18 \pm 0.09^{a, 1}$	$0.20 \pm 0.05^{X, 1}$	0.15 ± 0.08^{1}	$0.15 \pm 0.07^{X, 1}$	$0.64 \pm 0.19^{B, a, 2}$	$0.67 \pm 0.17^{X, a, 2}$
	Zyretec	$0.26 \pm 0.05^{a, 1}$	$0.27 \pm 0.06^{X, Y, a, 1}$	$0.20 \pm 0.05^{1*}$	$0.38 \pm 0.26^{Y, a, 1*}$	$0.41 \pm 0.17^{A, 2*}$	$0.56 \pm 0.10^{X, Y, a, 2*}$
	Depakin	0.21 ± 0.05^{1}	$0.24 \pm 0.03^{X, 1}$	0.20 ± 0.03^{1}	$0.24 \pm 0.04^{X, 1}$	$0.51 \pm 0.27^{A, a, 2}$	$0.56 \pm 0.12^{X, Y, a, 2}$
1 Week	Distilled water	$0.29 \pm 0.09^{A, 1}$	$0.21 \pm 0.04^{X, 1}$	$0.30 \pm 0.15^{A, a, 1}$	$0.25 \pm 0.05^{X, 1}$	$0.68 \pm 0.13^{A, b, 2*}$	$0.80 \pm 0.23^{X, b, 2*}$
	Amoklavin	$0.28 \pm 0.23^{A, 1*}$	$0.42 \pm 0.13^{Y, b, 1*}$	$0.19 \pm 0.03^{B, 1}$	$0.25 \pm 0.15^{X, 2}$	$0.60 \pm 0.39^{A, b, 2*}$	$0.94 \pm 0.26^{X, b, 3*}$
	Parol	$0.30 \pm 0.05^{A, a, 1*}$	$0.53 \pm 0.31^{Y, a, b, 1*}$	$0.17 \pm 0.03^{B, 1}$	$0.32 \pm 0.11^{X, a, b, 2}$	$0.75 \pm 0.24^{B, b, 2}$	$0.64 \pm 0.19^{Y, b, 1}$
	Ventolin	$0.20 \pm 0.10^{B, a, 1}$	$0.24 \pm 0.07^{X, 1}$	$0.18 \pm 0.06^{B, 1}$	$0.19 \pm 0.08^{X, 1}$	$0.74 \pm 0.25^{B, a, 2}$	$0.81 \pm 0.23^{X, a, 2}$
	Zyretec	$0.40 \pm 0.10^{C, b, 1}$	$0.36 \pm 0.15^{X, b, 1}$	$0.24 \pm 0.07^{A, B, 2*}$	$0.49 \pm 0.36^{Y, b, 2*}$	$0.50 \pm 0.26^{C, 2*}$	$0.75 \pm 0.03^{X, b, 3*}$
	Depakin	$0.24 \pm 0.06^{A, B, 1}$	$0.28 \pm 0.02^{X, 1}$	$0.24 \pm 0.05^{A, B, 1}$	$0.28 \pm 0.04^{X, 1}$	$0.61 \pm 0.33^{A, a, 2*}$	$0.81 \pm 0.15^{X, a, 2*}$
4 Week	Distilled water	$0.29 \pm 0.11^{A, 1}$	$0.26 \pm 0.05^{X, 1}$	$0.32 \pm 0.17^{A, b, 1}$	$0.31 \pm 0.08^{X, 1}$	$0.74 \pm 0.10^{A, c, 2}$	$0.88 \pm 0.29^{X, b, 2}$
	Amoklavin	$0.31 \pm 0.22^{A, 1*}$	$0.52 \pm 0.16^{Y, c, 1*}$	$0.21 \pm 0.03^{B, 1}$	$0.29 \pm 0.20^{X, 2}$	$0.77 \pm 0.40^{A, c, 2*}$	$1.12 \pm 0.31^{Y, c, 3*}$
	Parol	$0.37 \pm 0.12^{B, b, 1*}$	$0.66 \pm 0.42^{Y, c, 1*}$	$0.23 \pm 0.07^{B, 2}$	$0.39 \pm 0.15^{X, b, 2}$	$0.88 \pm 0.25^{B, c, 3*}$	$0.69 \pm 0.20^{Z, b, 1*}$
	Ventolin	$0.33 \pm 0.14^{A, B, b, 1}$	$0.32 \pm 0.12^{X, 1}$	$0.19 \pm 0.08^{B, 2}$	$0.23 \pm 0.07^{X, 1}$	$0.95 \pm 0.39^{B, b, 3}$	$0.94 \pm 0.47^{X, b, 2}$
	Zyretec	$0.43 \pm 0.11^{C, b, 1}$	$0.46 \pm 0.10^{Y, c, 1}$	$0.30 \pm 0.09^{A, 2*}$	$0.51 \pm 0.40^{Y, b, 1*}$	$0.55 \pm 0.38^{C, 3*}$	$0.83 \pm 0.09^{X, b, 2*}$
	Depakin	$0.28 \pm 0.07^{A, 1}$	$0.31 \pm 0.04^{X, 1}$	$0.25 \pm 0.04^{A, B, 1}$	$0.36 \pm 0.15^{X, 1}$	$0.97 \pm 0.27^{B, b, 2*}$	$1.26 \pm 0.26^{Y, b, 2*}$

The letters A, B, and C were used to compare the solutions of non-brushed samples of the same material in the same week.

The letters X, Y, and Z compare the samples of the same material in the same brushing condition according to the solutions in the same week.

The letters a, b, and c were used to compare the same solution, same material, and brushing condition over time.

The exponent numbers 1, 2, and 3 were used to compare the samples in the same brushing condition, at the same time, and in the same solution according to the materials.

The * sign indicates the difference between brushed and unbrushed samples of the same material and solution in the same period.

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Statistical analyses were performed using the SPSS 23.0 software package, with a statistically significant level of 0.05. The values were expressed as mean ± standard deviation. Data were evaluated using post-hoc analysis, the Bonferroni test, and the four-factor repeated-measures analysis of variance (ANOVA), with the general linear model procedure for repeated measures. In this analysis, material, drug (solution), brushing or non-brushing, and time, along with their interactions, were considered.

RESULTS

The effect of material, solution, and brushing status on the change in SR values over time is shown. Data were evaluated using a 3 (material) x 6 (solution) x 2 (brushing status) design and a three-factor repeated-measures ANOVA. Time had a statistically significant effect on SR values (F: 43.59, *p*: 0.001). Solution (drug) type alone did not have a statistically significant effect on SR values (F: 0.96, *p*: 0.443). Brushing status had a statistically significant effect on Ra values (F: 30.00, *p*: 0.001). The material also had a statistically significant effect on SR values (F: 349.06, *p*: 0.001). Statistical analysis showed that all variables, except for the solution (drug) among the four factors, had an individual effect. The interaction between time and solution did not have a statistically significant effect on SR measurements (F: 0.51, *p*: 0.884). The interaction between time and material had a statistically significant effect on SR measurements (F: 7.29, *p*: 0.001). The interaction between solution (drug) and material significantly affected SR measurements (F: 6.47, *p*: 0.001). The triple interaction of brushing, solution, and material had a statistically significant effect on SR measurements (F: 3.21, *p*: 0.001). No statistical significance was found in the double or triple-time interactions ($p > 0.05$). The total interaction of the four factors did not have a statistically significant effect on SR measurements (F: 0.78, *p*: 0.734). Thanks to the obtained model, it was observed that the SR value display rate was 62.2% (adjusted $R^2 = 0.622$; Table 3).

In the first and fourth-week measurements, the brushing/non-brushing samples immersed in Amoclavine, Parol, and Ventolin solutions were statistically significant compared to the materials ($p < 0.05$). Among these measurement values, GIC, compomer, and CR were in the order of height (Table 4). Statistically significant variance was observed when the brushed samples immersed in distilled water solution were compared according to the materials in the first and fourth-week measurements ($p < 0.05$). Among these measurement values, GIC, CR, and compomer were in the order of height. Among these measurement values, GIC, compomer, and CR were in the order of height in the non-brushing group (Table 4).

A statistically meaningful variance was observed in the non-brushing samples immersed in Zyrtec in relation to the materials in the first and fourth-week measurements ($p < 0.05$). Among these measurement values, it was observed that GIC, compomer, and CR were in the order of height (Table 4). A statistically meaningful variance was observed in the non-brushing samples immersed in Zyrtec according to the materials in the first and fourth-week measurements ($p < 0.05$). Among these measurement values, it was observed that GIC, CR, and compomer were in the order of height (Table 4).

Table 5. Roughness changes over time

		Compomer		Composite		Glass Ionomer Cement	
		Non-brushing	Brushing	Non-brushing	Brushing	Non-brushing	Brushing
1 Week to the beginning	Distilled water	0.06 ± 0.08	0.03 ± 0.01	0.10 ± 0.14	0.04 ± 0.02	0.14 ± 0.15	0.16 ± 0.14
	Amoklavin	0.03 ± 0.01	0.10 ± 0.09	0.01 ± 0.07	0.07 ± 0.10	0.10 ± 0.10	0.29 ± 0.21
	Parol	0.04 ± 0.02	0.09 ± 0.10	0.02 ± 0.01	0.09 ± 0.11	0.21 ± 0.29	0.15 ± 0.08
	Ventolin	0.03 ± 0.02	0.04 ± 0.03	0.02 ± 0.03	0.03 ± 0.03	0.11 ± 0.08	0.14 ± 0.14
	Zyretec	0.15 ± 0.08	0.10 ± 0.14	0.04 ± 0.03	0.10 ± 0.10	0.09 ± 0.10	0.18 ± 0.12
	Depakin	0.03 ± 0.02	0.04 ± 0.02	0.03 ± 0.03	0.04 ± 0.05	0.10 ± 0.08	0.24 ± 0.18
4 Week to the beginning	Distilled water	0.08 ± 0.07	0.08 ± 0.07	0.11 ± 0.16	0.10 ± 0.05	0.21 ± 0.14	0.25 ± 0.20
	Amoklavin	0.06 ± 0.04	0.20 ± 0.11	0.02 ± 0.07	0.10 ± 0.17	0.28 ± 0.17	0.47 ± 0.23
	Parol	0.11 ± 0.11	0.22 ± 0.18	0.07 ± 0.07	0.17 ± 0.18	0.34 ± 0.29	0.20 ± 0.12
	Ventolin	0.15 ± 0.17	0.12 ± 0.08	0.04 ± 0.03	0.07 ± 0.04	0.32 ± 0.24	0.27 ± 0.37
	Zyretec	0.17 ± 0.08	0.20 ± 0.15	0.09 ± 0.06	0.12 ± 0.19	0.15 ± 0.22	0.26 ± 0.19
	Depakin	0.07 ± 0.07	0.07 ± 0.04	0.04 ± 0.03	0.12 ± 0.14	0.46 ± 0.17	0.69 ± 0.22
4 Week to 1 week	Distilled water	0.02 ± 0.02	0.05 ± 0.07	0.02 ± 0.02	0.06 ± 0.04	0.06 ± 0.03	0.08 ± 0.07
	Amoklavin	0.03 ± 0.05	0.10 ± 0.06	0.02 ± 0.02	0.04 ± 0.06	0.17 ± 0.15	0.18 ± 0.08
	Parol	0.06 ± 0.10	0.13 ± 0.11	0.05 ± 0.07	0.06 ± 0.07	0.13 ± 0.10	0.05 ± 0.05
	Ventolin	0.12 ± 0.17	0.08 ± 0.06	0.02 ± 0.02	0.04 ± 0.04	0.21 ± 0.20	0.13 ± 0.40
	Zyretec	0.03 ± 0.01	0.10 ± 0.14	0.06 ± 0.07	0.02 ± 0.13	0.05 ± 0.15	0.08 ± 0.07
	Depakin	0.05 ± 0.08	0.03 ± 0.03	0.02 ± 0.01	0.08 ± 0.12	0.37 ± 0.17	0.45 ± 0.34

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A statistically significant difference was found in the comparison between the materials in the first-week measurement of the unbrushed samples immersed in Depakin ($p < 0.05$). It was determined that the highest measurement SR value was GIC, and the means were equal for composite and compomer (Table 4). A statistically meaningful variance was observed in the brushing samples immersed in Depakin according to the materials in the first and fourth-week measurements ($p < 0.05$). Among these measurement values, it was observed that GIC, CR, and compomer were in the order of height.

In comparing the roughness change between the groups at week 1 and week 4 to the baseline, it was shown that the lowest roughness change value occurred in the non-brushing CR material samples stored in Amoclavine. However, the highest SR change value was observed in the brushing GIC material samples stored in Amoclavine at week 1. In contrast, it was determined that the highest SR change value was seen in the brushing GIC material samples stored in Depakin at week 4 (Table 5).

In addition, comparing the difference in SR change in the fourth week to the first week, it was shown that the lowest SR change value was demonstrated in the samples of the non-brushing CR and compomer materials kept in distilled water, as well as in the samples of the non-brushing composite material immersed in Amoclavine. The highest SR change value was found in the samples of the brushing GIC material in Depakin (Table 5).

DISCUSSION

In light of the data obtained in this study, which was designed in an *in vitro* environment, it was shown that pediatric medication and brushing affected the SR of the restorative materials used in pedodontics over time, and the effects of these drugs differed. Liquid medicines commonly used for children contain high amounts of sugar. Additionally, these drugs have a low pH, which causes the plaque's pH to decrease, potentially initiating caries formation and eroding primary and permanent teeth as well as dental restorations.[25] In addition, tooth brushing, a widely used oral hygiene method, has the effect of causing tooth wear and affecting dental filling materials.[24]

In pediatric dentistry, CR and compomers containing resin, as well as filling materials containing GIC, are widely used in dental restorations. When considering this, the difference in the initial SR values of the filling materials is due to the shape, size, volume, and distribution of the inorganic compounds.[26] With this in mind, restorative materials with different contents and properties were used in this study. The brushing process was simulated, and the effectiveness of various pediatric drugs on the surface properties and topography was evaluated after application.

Different methods were used in studies evaluating the effects of drugs on dental materials, especially with regard to immersion periods. In most studies, the continuous immersion method in liquids was employed.[27] Considering similar studies and aiming to simulate the study accurately, specimens were immersed in pediatric medications for one minute every eight hours and then kept in distilled water.[24] In their study, Turssi et al.[28] showed that the micromorphological properties of resin-based filling materials kept in artificial saliva or distilled water were affected at the same rate. Therefore, in this study, we chose distilled water to preserve the samples.[28]

A contact profilometer device, capable of measuring at the micron level, is often used in SR evaluations. This device can calculate many parameters that indicate SR values.[29] In our study, we used a profilometer device that can make qualitative measurements. It has been stated that the acceptable value for SR is 0.2 µm. For this reason, SR above 0.2 µm on average in dental restorations increases bacterial colonization.[30] In their study, Candan and Unal evaluated the effects of restorative materials immersed in asthma medications with different contents on SR. They found that the resin-modified glass ionomer exceeded the 0.2 µm value at the examined times and in all drug groups. In the third week, the traditional GIC material in the Ventolin group and the compomer materials in the combined drug group exceeded this critical value.[2] Results partially similar to our study were obtained. In this study, as mentioned previously, it was observed that the acceptable Ra value (0.2 µm)[30] was always exceeded in compomer and GIC samples. In contrast, in CR samples, it was observed that the samples without brushing were below this value in the first week with Amoclavine and Parol drugs. Similarly, in the Ventolin drug group, the value was below the threshold in the first week. It was also observed that the composite samples, whether brushed or not, were below this value. Additionally, it was noted that the non-brushed CR samples kept in Ventolin for the fourth week were below this value.

Glass ionomer cement is a dental restorative material with high roughness to which bacteria and plaque can adhere.[31] Its heterogeneity and higher rough surface may be due to glass particles in its composition. Additionally, due to its contents, pores may occur when applied manually, as air bubbles can remain undetected by the eye.[32] Our results showed that the material with the highest SR was GIC. In the study, it was recommended that brushing should be done 60 minutes after this application due to the increased risk of wear on surfaces that have been worn or softened by acid exposure.[33] It is also known that fluoride particles in toothpaste negatively affect the resin matrix of dental restorative material and its monomer.[24] Therefore, this study used non-content fluoride toothpaste and an electric toothbrush that shows the force to standardize the abrasive effect of tooth brushing.

Additionally, Pinelli et al.[34] stated that the bleaching and brushing process increased the SR of the CR filling material over time. In a study by Carvalho et al.,[7] where the SR of traditional GIC, resin-modified GIC, nanoparticle-

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containing GIC, and nanoparticle-containing CR was evaluated after brushing, the highest Ra value was observed in the conventional GIC material. In contrast, the lowest value was observed in the CR material. It has also been observed that brushing increases SR.

In our study, the effectiveness of brushing was evaluated in addition to the impact of medications on the SR of the materials, and the results obtained were in line with those of Pinelli et al.[34] and Carvalho et al.[7] Our study concluded that brushing increased SR in all groups. In restoration materials containing resin, hydrolysis of the silane interface occurs with water absorption, causing the chemical bonds between the filling particles to weaken. Thus, water absorption of the material negatively affects the mechanical and physical properties, leading to deterioration of the material's surface.[35] This situation negatively impacts the surface properties, resulting in a rough structure. It also has adverse effects on surface microhardness.[36] Water is essential in adjusting and sustaining the chain reaction in GIC and GIC-based restorative materials. However, excessive water absorption of the material causes it to expand and negatively affects its physical properties.[37,38]

In a study by dos Santos et al.,[39] which compared the effects of the drug amoxicillin on the SR of resin-containing filling materials such as compomer and composite, it was shown that the Ra value of compomer was higher than that of the CR material. This study demonstrated that the lowest Ra values in all brushed/non-brushed groups kept in the amoxicillin (Amoklavin) group at the first and fourth weeks were in the CR, compomer, and GIC materials. Additionally, when comparing the roughness change difference experienced in the first and fourth weeks according to groups, it was observed that the lowest roughness change value occurred in the samples of the non-brushing composite material immersed in Amoklavin (amoxicillin). Ozan et al.,[27] in a study where they evaluated the effects of pre- and probiotics on different aesthetic filling materials used in pedodontics (traditional GIC, resin-modified GIC, compomer, and CR), observed that the material that most affected the SR was in the traditional GIC group. Subramaniam et al.,[8] in their study evaluating the effects of antihistaminic inhaler drugs on the SR of restorative materials, observed that GIC and CR significantly affected the SR but did not cause a significant change in alkacid restorative materials. Additionally, Ayaz et al.[40] found that an asthma drug (salbutamol sulfate) affected the SR and color of CR and GIC filling materials. In this study, the effect of the inhaler bronchodilator drug (Ventolin) on all restorative materials was observed, showing that SR increased over time. Furthermore, Gurdogan Guler et al.,[38] in a study, observed that Ketac Molar, a traditional GIC-containing material, had higher SR values than CR in all vitamin drug groups and the control group at every time. In another study, where they examined the effects of CR and resin-modified GIC materials on the SR of acidic drinks, it was determined that the initial and post-Ra values were lower in CR.[41]

Jamal et al.,[42] in a study observing the effect of pediatric syrups with different contents on the SR of dental filling materials such as resin-modified GIC, compomer, and CR, found that SR increased on the 14th day. It was also observed that the resin-modified GIC material showed better surface stability than the other materials. Two reasons have been suggested for this. The first is that GIC material absorbs more water than the others. Second, the resin-rich layer was not entirely removed when using Mylar strip tape to smooth the restoration surface.[42] The results obtained in this study are similar to those of other studies, and it has been observed that the SR of resin-containing materials is lower than that of traditional GIC. In general, the lowest Ra values were seen in composite samples.[27,35,38,41,42] This should be kept in mind in clinical practice for individuals who frequently use medications. However, since this study is *in vitro*, it cannot fully replicate conditions inside the mouth. Additionally, we believe that the in-depth assessment of only one brand of dental restorative material and the extrapolation of these results to all dental filling materials are limitations.

Consequently, in this study, we observed that the stability of SR in resin-containing esthetic filling materials against drugs and brushing was better than that of traditional GIC materials. Thus, when choosing restorative materials for children who require frequent medication, it may be better to use those containing resin, as their SR is more stable. In addition, considering that brushing negatively affects SR, attention should be paid to the brushing method, duration, and strength. The findings of this study may contribute to the literature, serve as a reference for future clinical studies, and highlight the need for long-term clinical studies on this subject.

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