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Effect of Mouthwashes and Brushing Simulation on the Surface Roughness of a Bulk Filled Composite Resin - An *in vitro* Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Introduction: Dental caries is one of the most common chronic diseases seen in the world and it's restoration is one among the most common procedures done by dentists throughout. In this article the influence of mouthwashes and simulated tooth brushing on the surface roughness of a bulk filled composite resin is checked. The aim of the study is to analyse the effect of mouthwashes and brushing simulation on the surface roughness of a bulk filled composite resin.
Materials and Methods: The present study was an *in vitro* study conducted in a university dental hospital located in Chennai. The bulk fill composite resin (ivoclar vivadent brand) was manipulated into putty moulds. The specimens were divided into two groups, group 1 and group 2. Two mouthwashes were selected namely chlorhexidine gluconate and betadine 2%. Group 1 was subjected to immersion in chlorhexidine gluconate and group 2 was subjected to immersion in betadine. Ra, Rq and Rz surface roughness values of these specimens was calculated before immersion in mouthwash. The brushing was performed, with a dentifrice slurry (Colgate and distilled water). Each specimen was subjected to toothbrushing with a soft toothbrush. The

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specimens underwent 1000 cycles of brushing after which the surface roughness analysis was performed. Toothbrush simulator ZM 3.8 and a stylus profilometer (Mitutoyo SJ-310) was used. For statistical analysis, independent sample t test using SPSS statistics version 22.0 was done.
Results: The mean value of group 1 Ra and group 2 Ra was 0.030 and the p value was 0.000. The mean value of group 1 Rq and group 2 Rq was 0.0239 and 0.0215 respectively and the p value was found out to be 0.134. The mean value of group 1 Rz and group 2 Rz was 0.0030 and 0.0035 respectively and the p value was found to be 0.033. There was no significant changes in surface roughness values between the groups after brushing simulation.
Conclusion: Within the limitations of this *in vitro* study, we found that composite resin samples immersed in chlorhexidine and povidone iodine mouthwash had similar surface roughness values after brushing simulation.

Keywords: Brushing simulation; composite resin; mouthwashes; restorative material; surface roughness.

1. INTRODUCTION

Dental caries is one of the most common diseases of the world and their prevention is key for maintaining proper oral hygiene. Prevention starts right at home with brushing, flossing and the use of mouthrinses [1]. Removal of caries can be done by excavating them and sealing the cavity with a dental restorative cement such as composite resin or glass ionomer cement. The main aim of using a dental restorative cement is to restore all the mechanical and biological functions of a natural tooth [2]. Dental restorative cement like composite is one of the most commonly used restorative cement by dentists owing to its excellent properties and aesthetics. Maintenance of oral hygiene still stays important after removal of caries and is key to prevent the formation of secondary caries [3]. Composite restorations have become an indispensable element for posterior teeth restorations in modern dentistry. In many clinical trials and studies, the performance of composite restorations bearing the mastication load in the posterior teeth areas has been proven conclusively. Apart from the highly aesthetic properties of composite it also has the demand for the most efficient and economic restorative material in the market.

Mouthrinses often complement brushing in patients with splints or prostheses, implants, orthodontic braces. In this article the influence of mouthwashes and simulated tooth brushing on the surface roughness of a bulk filled composite resin is checked. The mechanical properties of composite resin can be influenced by tooth brushing. The surface roughness can increase due to wearing of the surface from brushing teeth. Toothbrushing abrasion is a prime issue in restorative dentistry. Brushing can expose the filler particles and cause them to loosen due to continuous wearing leading to abrasion of the surface of composite. Tooth brushing is important to maintain oral hygiene, but its continuing action may damage the surface of composite resin restorations. The mechanism is it makes surface rougher and thereby prone to surface staining, dental plaque accumulation and the soft tissue surface inflammation around restorative sites in patients. A tooth brushing simulator is a device that will simulate various tooth brushing movements on the surfaces of teeth and test pieces. The brushes present in the simulator are controlled by a central driven system and hence the movement of brushing is the same for all the brushes present in the simulator [4]. The motion sequence for cleaning teeth can be a combination of backward, forward or circular motion.

A mouthrinse or a mouthwash is a medicated liquid that is used for maintenance of oral hygiene. There is a wide range of options for the kinds of mouthrinses available and they all differ in their antimicrobial and analgesic or astringent properties. Chlorhexidine is a prescription germicidal mouth rinse with excellent antibacterial properties. It is an effective antiseptic mouthwash. CHX is highly effective and is commonly prescribed for maintenance of good oral hygiene [5]. Betadine containing povidone-iodine is an effective antiseptic and disinfectant agent that is used as a mouthwash to kill germs that cause infections of the mouth [6,7]. It also relieves dryness of the mouth and sore throat. Betadine mouthrinse is also prescribed in COVID-19 patients owing to its excellent antimicrobial properties. The alcohol content in the commercially available mouthwashes can influence the surface degradation of composite resin restorations. The

aim of the study is to analyse the effect of mouthwashes and brushing simulation on the surface roughness of a bulk filled composite resin.

2. MATERIALS AND METHODS

8 specimens were prepared with bulk filled composite resin. Sample size is from pilot investigation. Sample dimensions was 8mm diameter and 2 mm thickness. The composite resin (ivoclar vivadent) was manipulated into putty moulds and they were pressed with a glass slab to smoother the surface. Finally the samples were mounted on die stone [Fig. 1]. They were then cured for 20 seconds using an LED light curing unit. The cured specimens were removed and polished. The surface roughness of these specimens was calculated before immersion in mouthwash. The specimens were divided into two groups, group 1 and group 2. Two mouthwashes were selected namely chlorhexidine gluconate and betadine 2%. Group 1 was subjected to immersion in chlorhexidine gluconate and group 2 was subjected to immersion in betadine. During a period of 5 days, each sample was immersed in 20 mL of mouthrinse for one minute under manual agitation, once a day (24 hour interval between exposures). Samples were placed in artificial saliva between immersions. After 5 days of immersion, they were subjected to brushing by means of a brushing simulator (Toothbrush simulator ZM3.8). The machine allows 8 specimens to be brushed simultaneously [Fig. 2]. In this study, a 200-g force was applied, using toothbrush simulator. Brushing was made mounted sample on top surface. X axes, Y axes, circular and zigzag movements were followed. The brushing was performed, with a dentifrice slurry (Colgate and distilled water). Each specimen was subjected to toothbrushing with a soft toothbrush. The specimens underwent 1000 cycles of brushing after which the surface roughness analysis was performed. Stylus profilometer (Mitutoyo SJ-310) was used to measure surface roughness. Ra, Rq and Rz values were measured.

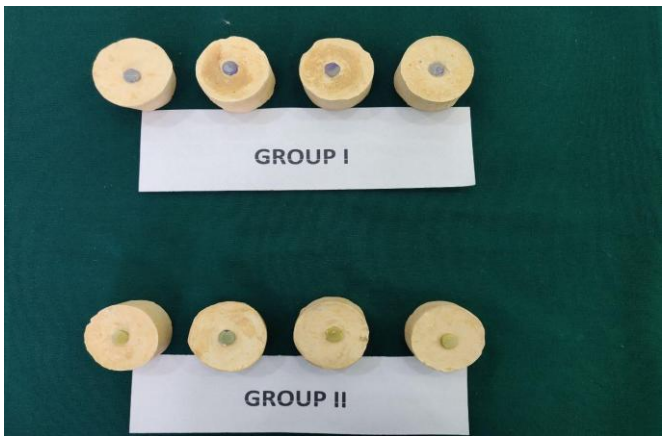

Fig. 1. Group I sample immersed in CHX and Group II sample immersed in povidone iodine mouthwash

Fig. 2. Samples before they underwent brushing simulation

3. RESULTS AND DISCUSSION

Independent sample t test was used and p value of less than or equal to 0.005 is considered statistically significant, using SPSS statistics version 22. From the results obtained, the Ra, Rq and Rz values of Chlorhexidine and Povidone for pre and post surface roughness was obtained (Table 1). From the raw data we can conclude that the surface roughness of composite rinsed in both CHX and Povidone remains the same before and after brushing simulation. The difference of Ra, Rq and Rz values of surface roughness prior to brushing simulation and after brushing simulation was analysed and the composite discs immersed in both the mouthwashes ie CHX and Povidone was analysed and they did not show much deviation after brushing simulation. The mean value of group 1 Ra and group 2 Ra was 0.030 and the p value was 0.000. Ra values were found to be statistically significant. The mean value of group 1 Rq and group 2 Rq was 0.0239 and 0.0215 respectively and the p value was found out to be 0.134. The mean value of group 1 Rz and group 2 Rz was 0.0030 and 0.0035 respectively and the p value was found to be 0.033 [Table 2]. We found that composite resin samples immersed in chlorhexidine and povidone iodine mouthwash had similar surface roughness values. There was no significant changes in surface roughness values between the groups after brushing simulation.

Our team has extensive knowledge and research experience that has translated into high quality publications [8–20,21–25,26,27]. Composite materials can degrade due to any mechanical or chemical factors from the oral environment including the composition of saliva, masticatory stress exerted, toothpaste used, force of brushing, textures of food particles etc [28]. Any of these factors can cause changes in the surface roughness of the composite resin, it's discolouration, loss of gloss, and polish affecting the aesthetics of the restorative materials. All these changes have been attributed to the degradation of composite and the loss of inorganic filler particles. In a non stress bearing area, the change arises due to the interaction between oral hygiene materials like toothpaste or mouthwashes. The side effects of mouth rinsing followed by tooth brushing need to be evaluated as it could affect the surface smoothness of the restorative material [29].

The degradation of a certain type of composite material, bulk filled composite in this case, depends on varying factors like volume and type of inorganic filler. In the study done by *Keico et.al* different results of surface roughness have been obtained. The specimens were immersed in artificial saliva first during the experimental period. This procedure influenced roughening from toothbrushing, because the saliva contains specific proteins and ions that may diminish the roughening effect of the toothbrush. However, in our study, the specimens were directly immersed in mouthwashes followed by toothbrushing. Hence the surface roughness values between both the studies gave varied results, with *Keico et.al* s results showing lower surface roughness values for Colgate Plax Fresh Mint ($p < 0.05$). All other groups tested (Oral B, Cepacol, Colgate Plax, artificial saliva) exhibited no statistically significant differences between surfaces, whether subjected to toothbrushing or not [30].

Table 1. This table represents the Ra, Rq and Rz values of composite rinsed in CHX and Povidone before and after brushing simulation

Samples	Surface roughness value prior to brushing simulation			Surface roughness value after brushing simulation		
	Ra	Rz	Rq	Ra	Rz	Rq
CHX 1	0.003	0.022	0.004	0.003	0.021	0.004
CHX 2	0.003	0.025	0.004	0.003	0.020	0.004
CHX 3	0.003	0.023	0.004	0.003	0.019	0.004
CHX 4	0.003	0.022	0.004	0.003	0.021	0.004
Povidone 5	0.003	0.024	0.004	0.003	0.019	0.003
Povidone 6	0.003	0.027	0.004	0.003	0.020	0.003
Povidone 7	0.003	0.024	0.004	0.003	0.021	0.003
Povidone 8	0.003	0.024	0.004	0.003	0.021	0.003

Table 2. Significant testing on surface roughness between groups before and after brushing simulation

	Mean	Standard deviation	Standard Error mean	P value
Group 1 Ra	0.0030	0.0000	0.0000	0.000
Group 2 Ra	0.0030	0.00000	0.00000	
Group 1 Rq	0.0239	0.00164	0.00058	0.134
Group 2 Rq	0.0215	0.00312	0.00110	
Group 1 Rz	0.0030	0.00000	0.00000	0.033
Group 2 Rz	0.0035	0.0053	0.00019	

The limitations of this study were less sample size. Only composite was used as a restorative material and the study could have used more restorative materials. More parameters could have also been included in the study apart from surface roughness. The brushing simulations on the restorative materials underwent only 1000 cycles and more cycles could have been included. Povidine and chlorhexidine were the only mouthwashes tested when many other mouthwashes which were commercially available could have been used.

4. CONCLUSION

Within the limitations of this *in vitro* study, we found that composite resin samples immersed in chlorhexidine and povidone iodine mouthwash had similar surface roughness values after brushing simulation. There was no increase or decrease in surface roughness values after brushing simulation, which means mouthwash immersion had no effect on surface roughness parameter of the bulk fill composite resin samples.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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