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COMPARATIVE EVALUATION OF THREE SURFACE SEALANTS COATED ON COMPOSITE RESIN AGAINST STREPTOCOCCUS MUTANS ADHESION – AN INVITRO STUDY

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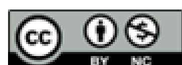

Abstract

Background: One of the most crucial procedures for the success of a composite restoration is finishing and polishing. In this study,three surface sealant polishing systems were examined and contrasted with two finishing systems and evaluated for surface roughness and adherence of two strains of Streptococcus Mutans. **Materials and Methods:** 110 resin composite discs made of Filtek Z 250 (8 mm x 1 mm) were randomly divided into five groups of 22 discs, each based on the finishing and polishing system employed. In Group 1, discs were finished with Mylar Strip alone. In Group 2, discs were finished and polished with Caulk Micropolisher. In Group 3, Permaseal (PS) was applied over finished and polished discs. In Group 4, Optiguard (OG) was applied over finished and polished discs. In Group 5, G Coat plus (GCP) was applied over finished and polished discs. **Result:** Mylar strip showed the smoothest mean surface value, followed by Permaseal, Optiguard, and G Coat Plus. Caulk had the highest mean roughness value. Permaseal and Optiguard had smoother finishes compared to Caulk micro polisher alone. Permaseal and Optiguard had the least Streptococcus mutans counts, followed by Mylar while G Coat plus had the highest. At 18-hour incubation, the mean CFUs were least in Permaseal, followed by Optiguard and Mylar. The highest mean value of CFUs was observed in G coat plus, followed by Caulk. The mean colony-forming units significantly increased between 6 and 18 hr in the Caulk micro polisher. **Conclusion:** This in-vitro study noted that applying surface sealants reduces surface roughness and decreases Streptococcus mutans adhesion on the restorative composite resin surface.

INTRODUCTION

Aesthetic restorations are an indispensable component of current dentistry practice. The most prevalent and preferred aesthetic restorative material is composite. Due to its combination of aesthetics, practicality, conservation and economics, composite has seen tremendous growth in utilisation as a choice of restorative material for both the anterior and the posterior teeth in recent years. Composite has a good survival rate and lifespan if the treatment procedure is performed correctly. Dental restorations should be finished and polished properly to maintain oral health and fulfil cosmetic needs. The final step of the clinical treatment, finishing and polishing, is critical to the aesthetics and bio-integration of composite restorations. A rough composite resin surface may reduce gloss and aesthetic appeal and increase the number of locations on the surface of the restoration susceptible to bacterial biofilm buildup, which raises the risk of periodontal inflammation and caries. Streptococcus mutans (S. mutans) is known to be largely responsible for the start of tooth decay along with the advancement of an established lesion in dental biofilm development.[1-3]

In general bacterial adhesion to a surface is influenced by various factors, including the duration of exposure, the quantity of inoculated bacteria, the characteristics of the bacteria and the nutrients. Surface characteristics of the substrate, including surface charge density, hydrophobicity, roughness, stiffness, and surface topography are also thought to have a significant role in determining early bacterial adhesion to surfaces.[4] The fundamental

physicochemical properties of the restorative materials also influence the adhesion of the bacteria to the surface.[5]

Numerous types of research have also concluded that the surface characteristics of the substratum, substantially impact the adhesion of oral bacteria. Surface free energy and surface roughness of the substratum are two of the most important elements determining bacterial adherence. Glass and ceramics are less likely to have microbial encroachment on them than any other restorative materials. At the same time, polymers and composite resins tend to develop microbiological plaque to a greater degree than natural dental hard materials. Substratum surfaces with roughness have facilitated bacterial adherence to composite surfaces.[6,7]

To enhance the clinical effectiveness and success rate of these restorations, assessing the adherence and colonisation of S.mutans on restorative materials is crucial.[8] For bacterial retention, researchers have proposed a threshold surface roughness (Ra=0.2 m) below which no significant decrease in bacterial accumulation might be anticipated.[9]

Many methods are available to improve the polishing and finishing of composites. A composite resin treated, polished or covered with a surface sealant should typically have a low propensity to adhere to oral bacteria.[10] According to studies, using a mylar polishing method is a significant way to create a smooth surface that will have less bacterial adherence.[3,11,12]

Comparative studies assessing the strains of streptococcus retention on surfaces of composite resins finished and polished by the different techniques are far and few. This study aimed to fill this lacuna by evaluating the adhesion of clinical and standard strains of Streptococcus mutans on the dental composite resins coated with three commercially available surface sealants Permaseal (PS), Optiguard (OG) and G Coat Plus (GCP) and correlate the above finding to the surface characteristics of the coating material.

MATERIALS AND METHODS

Hundred and ten specimens were prepared for this in-vitro study using specially produced Teflon cylindrical moulds with 8 mm X 1 mm dimensions. The mylar strip was placed on a glass slide with the mould on top of it. Filtek Z 250 ((Filtek Z250; 3M) was filled in the mold space using Teflon coated instrument and another mylar strip and a glass slide was placed over it. Excess material was squeezed out after the glass slide had been pressed to create uniform surfaces on both sides. The glass slide was put close to the curing unit's (Ivoclar Bluephase NMC) tip [with a wavelength of 440–470 nm on high-power mode (1400 mW/cm2)] and cured for 20 seconds each on both sides. The so obtained specimens were randomly sorted into five groups of 22 specimens each.

Group 1 - Discs finished with Mylar Strip alone. Group 2 – Discs finished and polished with Caulk Micropolisher (Dentsply/Caulk, Milford, DE, USA). The flat portion of the polishing disc was used as per the product description. The discs were rinsed and air-thinned. Group 3 – Permaseal (Ultradent Product Inc. South Jordan, EUA) applied over finished and polished discs. Group 4 – Optiguard (Kerr Corp., Orange, CA, USA) applied over finished and polished discs. Group 5 – G Coat plus (GC Corporation, Tokyo, Japan) applied over finished and polished discs.

In Groups 3,4 and 5 the discs are polished with a micro polisher, rinsed and dried gently. Following the procedure, a thin coat of the specified surface sealants corresponding to each group was applied precisely and air-thinned to the surfaces. The coated surfaces were roofed with the Mylar strip and glass slide. Subsequently, it was light cured by positioning the light guide tip of the curing light (Ivoclar Bluephase N MC) across the glass slide and the same procedure was repeated on the other side of the disc. The surface sealants were applied according to the manufacturer's recommendations. After storing for 24 hours at room temperature, the mylar strips were removed from the specimens.

Surface Characterization: One depictive specimen of each group was sent for the Scanning Electron Microscope (SEM TESCAN VEGA3 SBU). Specimens were mounted in aluminium stubs, sputter-coated with platinum and analysed. The images were obtained in 500x magnification. Another depictive specimen from each group was analysed using a previously calibrated profilometer (Taylor Hobson) at a stylus speed of 0.1 mm/sec, a cut-off of 0.8 mm, and a range of 600 µm. Each specimen's surface roughness value Ra was the average of the readings recorded by the stylus.

Strains of bacteria used in this research: Standard strain: Streptococcus mutans Microbial Type Culture Collection (MTCC) 497 (Serogroup C, Original Source: carious dentine).

Clinical Strain: A stock culture of oral isolation of S. mutans from the unstimulated saliva of a patient with dental caries was used for the study. This strain had been isolated, identified, confirmed and stored in the Department of Microbiology, Sree Balaji Dental College & Hospital, Chennai, on Mutans sanguis agar. This strain was revived and employed in the investigation. Ten microliters of the respective bacterial culture were reconstituted and the inoculums were prepared. The inoculum was streaked on the agar surface for isolation. The plates were incubated at 37˚C with 5% CO2 in a candle jar for 24 hours. After incubation, the colony morphology of S. mutans was observed. Inoculums were seeded in sterile Brain Heart Infusion Broth (BHIB) (Difco, Detroit, MI, USA) in individual test tubes and the cell densities were adjusted.

The above specimens were used to inoculate the produced discs. Each subgroup had five discs (mylar, caulk, permaseal, optiguard, and G Coat Plus). The

discs were transferred aseptically into the respectively labelled wells in 24 well microtitre plates. One mL of sterile BHIB was added to each well. 10 µl of the S. Mutans inoculum was added to each well. The 24 well tissue culture plates were incubated at 37°C for 6 and 18 hours. After incubation, the discs were aseptically removed from the wells and were washed twice with sterile saline to remove the non-adherent cells. Then the discs were transferred into the labelled Eppendorf tubes
containing 1 mL of sterile saline (1 disc/ Eppendorf tube). The Eppendorf tubes were vortexed constantly to mechanically detach the cells adherent to the discs. The spread plate method uniformly seeded the inoculum on the agar surface. One plate was incubated aerobically overnight at 37˚C in a candle jar with 5% CO2. Colony count was performed in the Microbiology laboratory of Sree Balaji Dental College & Hospital using the standard Microbiological spread plate method. Colony count was performed using a digital colony counter (Deep vision, India) and the number of colony-forming units (cfu) was calculated and tabulated using the formula.
Cfu/ml = N x dilution factor X 100. (N = no. of colonies), where dilution factor = 100
The specimens in each group were further divided into four subgroups based on duration, with five specimens in each group. Subgroup A (Clinical): 6 hrs incubation, Subgroup A (Clinical): 18 hrs incubation, Subgroup B (MTCC): 6 hrs incubation, and Subgroup B (MTCC): 18 hrs incubation.
Statistical analysis: The data were evaluated and tabulated in an Excel sheet, analysed using SPSS software Version 25 (SPSS Inc., Chicago, IL, USA), at a significance level set at 0.05. Using the Shapiro-Wilk and Levene tests, respectively, all data were evaluated for the normality of the distribution and the equality of variances. The data was found to be normally distributed $p > 0.05$, but the variances were not homogeneous. Hence, One way ANOVA followed by Games-Howells post hoc test was employed to detect the statistically significant difference among five groups for four different parameters.

RESULTS

The descriptive data, standard deviation, mean, median, skewness and kurtosis are represented in [Table 1]. The mean of the number of colony-forming units was least in G3 (PS), followed by G4 (OG) and G1 (Mylar). The highest mean value of colony-forming units was observed in G5 (GCP), followed by G2 (Caulk). This signified that the surface sealants G3 (PS) and G4 (OG) had lesser mean colony counts similar to the control group G1(Mylar).

The behaviour of Clinical strains of streptococcus mutans analysis: At 6-hour incubation, Mylar (p =0.03), PS (p = 0.000), and OG (p = 0.002) groups showed statistically significant lesser mean colony counts than the Caulk group. Mylar, PS, and OG groups were more statistically significant than GCP. There was no significant difference between Mylar, PS and OG groups. Also, no significant differences were noted between Caulk and GCP groups. At 18 hour incubation, G1 (p = 0.008), G3 (p=0.000), G4 (p=0.000) was statistically significant than G5.

The behaviour of Standard strains of Streptococcus mutans analysis: At 6-hour incubation, Mylar (p = 0.15), PS (p =0.14), and OG (p =0.11) showed statistically significant lesser mean colony counts than Caulk and Mylar (p = 0.000), G3(PS) (p = 0.000), G4(p = 0.000) was statistically significant than G5. At 18-hour incubation, there was no statistical significance between the groups.

Games-Howells post hoc test was performed to analyse if confidence intervals for the differences between group means were statistically significant [Table 2] for both clinical and standard strains of S. Mutans at 6 hrs and 18 hrs incubation duration. Mylar, PS and OG performed better than Caulk and GCP in all the composite groups with clinical and standard strains at 6 hours. At 18 hours, PS and OG performed better in Clinical strains than Caulk and GCP.

The Mean Roughness Value (Ra) of the materials in the present study ranged between 0.007 – 0.38. The Ra value of the five groups is depicted in [Table 3]. The increase in mean colony forming units was associated with increased mean roughness values and the mylar strip achieved the smoothest mean surface value, followed by PS, OG and GCP. The surface polished with a Caulk micro polisher had the highest Mean Roughness Value. The surface sealants group consisting of PS, OG and GCP had a smoother finish than the surface finished with the Caulk micro polisher.

The representative SEM surface pictures at 500x for each group are shown in [Figure 1]. Mylar had the smoothest surface among the groups, while PS and OG had similar surfaces. Few microcracks and craters were observed in GCP, and the Caulk showed the roughest surface among the groups.

Table 1: Descriptive data

Strain	Groups	Description		Statistic	Std. Error
	G1	Mean		13800	457.165
		95% Confidence Interval for Mean	Lower Bound	12530.71	
			Upper Bound	15069.29	
		5% Trimmed Mean		13805.56	
		Median		14200	
		Variance		1045000	
		Std. Deviation		1022.252	
		Minimum		12500	

		Maximum	15000	
A 6 Hrs (Clinical)		Range	2500	
		Interquartile Range	1900	
		Skewness	-0.309	0.913
		Kurtosis	-1.787	2
	G2	Mean	27040	1562.562
		95% Confidence Interval for Lower Bound	22701.63	
		Mean Upper Bound	31378.37	
		5% Trimmed Mean	26933.33	
		Median	26000	
		Variance	12208000	
		Std. Deviation	3493.995	
		Minimum	24000	
		Maximum	32000	
		Range	8000	
		Interquartile Range	6600	
		Skewness	0.731	0.913
		Kurtosis	-1.299	2
	G3	Mean	10800	1291.511
		95% Confidence Interval for Lower Bound	7214.19	
		Upper Bound	14385.81	
		5% Trimmed Mean	10722.22	
		Median	10400	
		Variance	8340000	
		Std. Deviation	2887.906	
		Minimum	8000	
		Maximum	15000	
		Range	7000	
		Interquartile Range	5400	
		Skewness	0.709	0.913
		Kurtosis	-0.638	2
		Mean	15000	1080.74
	G4	95% Confidence Interval for Lower Bound	11999.38	
		Upper Bound	18000.62	
		5% Trimmed Mean	15011.11	
		Median	15200	
		Variance	5840000	
		Std. Deviation	2416.609	
		Minimum	12000	
		Maximum	17800	
		Range	5800	
		Interquartile Range	4700	
		Skewness	-0.149	0.913
		Kurtosis	-2.009	2
	G5	Mean	34240	2211.244
		95% Confidence Interval for Lower Bound	28100.6	
		Upper Bound	40379.4	
		5% Trimmed Mean	34088.89	
		Median	33200	
		Variance	24448000	
		Std. Deviation	4944.492	
		Minimum	29200	
		Maximum	42000	
		Range	12800	
		Interquartile Range	8600	
		Skewness	1.077	.913
		Kurtosis	1.121	2.000

Table 2: Post Hoc Tests Games-Howell

Mean Dependent Variable (I) groups (J) groups Difference (I-J)				Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
A 6 Hrs (Clinical)	G1	G2	- 13240.000*	1628.066	0.003	-19955.59	-6524.4
		G3	3000	1370.036	0.314	-2501.77	8501.77
		G4	-1200	1173.456	0.836	-5772.45	3372.45
		G5	- 20440.000*	2258.008	0.003	-30077.97	-10802
	G2	G1	13240.000*	1628.066	0.003	6524.41	19955.6
		G3	16240.000*	2027.215	0	9175.53	23304.5
		G4	12040.000*	1899.895	0.002	5272.84	18807.2
		G5	-7200	2707.619	0.157	-16813.36	2413.36
	G3	G1	-3000	1370.036	0.314	-8501.77	2501.77
		G2	- 16240.000*	2027.215	0	-23304.47	-9175.5

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		G4	-4200	1684.043	0.187	-10062.33	1662.33
		G5	- 23440.000*	2560.781	0	-32828.45	-14052
	G4	G1	1200	1173.456	0.836	-3372.45	5772.45
		G2	- 12040.000*	1899.895	0.002	-18807.16	-5272.8
		G3	4200	1684.043	0.187	-1662.33	10062.3
		G5	- 19240.000*	2461.219	0.002	-28574.69	-9905.3
	G5	G1	20440.000*	2258.008	0.003	10802.03	30078
		G2	7200	2707.619	0.157	-2413.36	16813.4
		G3	23440.000*	2560.781	0	14051.55	32828.5
		G4	19240.000*	2461.219	0.002	9905.31	28574.7
A 18 Hrs (Clinical)	G1	G2	-19930	6877.5	0.16	-48466.06	8606.06
		G3	7050	2348.446	0.097	-1175.05	15275.1
		G4	3910	2103.331	0.422	-3901.18	11721.2
		G5	- 11870.000*	2394.41	0.008	-20214.99	-3525
	G2	G1	19930	6877.5	0.16	-8606.06	48466.1
		G3	26980	6782.035	0.063	-1838.12	55798.1
		G4	23840	6701.104	0.095	-5276	52956
		G5	8060	6798.088	0.761	-20705.7	36825.7
	G3	G1	-7050	2348.446	0.097	-15275.05	1175.05
		G2	-26980	6782.035	0.063	-55798.12	1838.12
		G4	-3140	1766.352	0.451	-9428.13	3148.13
	G4	G1	-3910	2103.331	0.422	-11721.18	3901.18
		G2	-23840	6701.104	0.095	-52956	5276
		G3	3140	1766.352	0.451	-3148.13	9428.13
		G5	- 15780.000*	1827.019	0	-22334.81	-9225.2
	G5	G1	11870.000*	2394.41	0.008	3525.01	20215
		G2	-8060	6798.088	0.761	-36825.7	20705.7
		G3	18920.000*	2104.566	0	11644.95	26195.1
		G4	15780.000*	1827.019	0	9225.19	22334.8
B 6 Hrs (MTCC)	G1	G2	- 43150.000*	7244.136	0.015	-74283.49	-12017
		G3	2050	1635.084	0.724	-3748.56	7848.56
		G4	3490	1953.228	0.441	-3266.06	10246.1
		G5	- 27750.000*	2184.834	0	-35421.03	-20079
	G2	G1	43150.000*	7244.136	0.015	12016.51	74283.5
		G3	45200.000*	7183.592	0.014	13827.5	76572.5
		G4	46640.000*	7262.617	0.011	15573.35	77706.7
		G5	15400	7328.301	0.354	-15450.68	46250.7
	G3	G1	-2050	1635.084	0.724	-7848.56	3748.56
		G2	- 45200.000*	7183.592	0.014	-76572.5	-13828
		G4	1440	1715.109	0.91	-4708.43	7588.43
		G5	- 29800.000*	1974.842	0	-37128.2	-22472
	G4	G1	-3490	1953.228	0.441	-10246.06	3266.06
		G2	- 46640.000*	7262.617	0.011	-77706.65	-15573
		G3	-1440	1715.109	0.91	-7588.43	4708.43
		G5	- 31240.000*	2245.351	0	-39065.98	-23414
	G5	G1	27750.000*	2184.834	0	20078.97	35421
		G2	-15400	7328.301	0.354	-46250.68	15450.7
		G3	29800.000*	1974.842	0	22471.8	37128.2
		G4	31240.000*	2245.351	0	23414.02	39066
B 18 Hrs (MTCC)	G1	G2	-17000	5477.518	0.113	-38256.71	4256.71
		G3	80	2383.107	1	-9108.25	9268.25
		G4	3560	2273.324	0.572	-5769.44	12889.4
		G5	-17840	5539.675	0.1	-39390.41	3710.41
	G2	G1	17000	5477.518	0.113	-4256.71	38256.7
		G3	17080	5120.859	0.112	-4877.22	39037.2
		G4	20560	5070.7	0.064	-1593.62	42713.6
		G5	-840	7157.653	1	-25568.98	23889
	G3	G2	-17080	5120.859	0.112	-39037.22	4877.22
		G4	3480	1178.134	0.109	-727.89	7687.89
		G5	-17920	5187.292	0.101	-40181.7	4341.7
	G4	G1	-3560	2273.324	0.572	-12889.44	5769.44
		G2	-20560	5070.7	0.064	-42713.62	1593.62
		G3	-3480	1178.134	0.109	-7687.89	727.89
		G5	-21400	5137.782	0.059	-43856.64	1056.64
	G5	G1	17840	5539.675	0.1	-3710.41	39390.4
		G2	840	7157.653	1	-23888.98	25569
		G3	17920	5187.292	0.101	-4341.7	40181.7
		G4	21400	5137.782	0.059	-1056.64	43856.6

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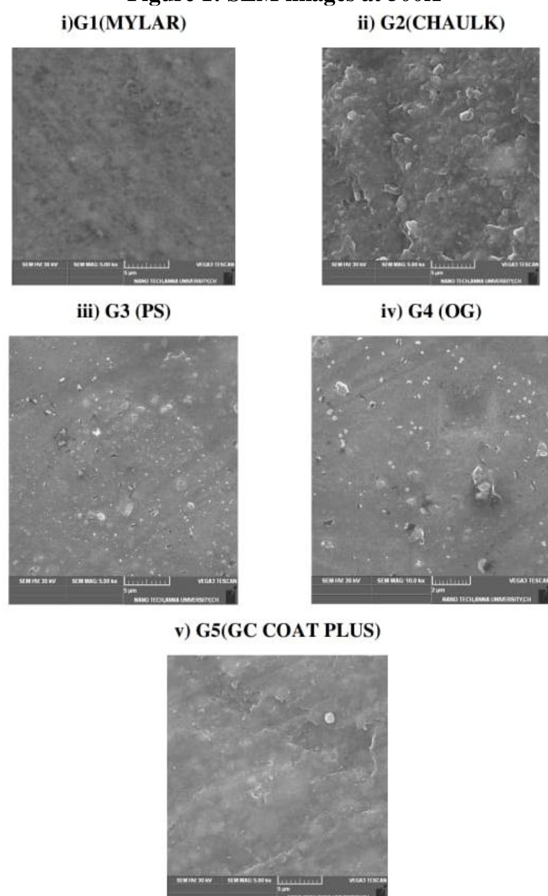
Table 3: Mean surface value Ra

Groups	Mean roughness values Ra IN µm
G1	0.0073
G2	0.3785
G3	0.0161
G4	0.0717
G5	0.1491

Figure 1: SEM images at 500X



DISCUSSION

In 1683, Anton Van Leeuwenhoek became the first scientist to use a microscope to view microorganisms. His tooth plaque or biofilm, was one of the first samples he looked at. Since then, interest in microbes has increased among researchers.[13]

Dental biofilms often bring many dental diseases, including microbial attachment to dental hard and soft tissues and restorative materials. The specific adhesive qualities of the adhering bacteria as well as the characteristics of the adhered substances, have an impact on the mechanisms by which oral bacteria cling to solid surfaces. The development of secondary caries and cariogenic biofilms on dental restorative materials are closely connected. The surface characteristics of restorative materials and the compositions of various chemicals are crucial in the early adhesion phase of bacteria.[14]

Dental composites made of polymers are an attractive alternative to amalgam. They are made of a hydrophobic resin matrix and hydrophilic filler particles, implying a heterogeneous surface.[14]

Restorative covering agents, often known as "surface sealants," are low-viscosity resins polymerized upon composite resin surfaces. These capillary actions penetrate and fix the microstructural defects after finishing and polishing operations. These materials maintain the surface smoothness of composite restorations, enhance wear resistance and guarantee good marginal sealing. The physicochemical surface properties of dental restorations including surface roughness, hydrophobicity and surface-free energy, greatly impact how oral bacteria adhere to the surfaces.[2]

The development of secondary caries, which affects the longevity of the restorations, remains the most common reason for a replacement despite advances in performance of restorative materials. Dental caries has been linked to several plaque-associated bacteria, with Streptococcus mutans being one of the key pathogens at play in its progression. Starting points for microbial colonisation of oral hard surfaces include surface imperfections where bacteria can grow shielded from hydrodynamic shear pressures. From a microbiological perspective, this is why the alteration of composite surface characteristics is becoming increasingly significant.[15]

This in-vitro study analysed the adherence of two strains of streptococcus mutans – clinical and standard to various polishing and finishing techniques on composite resin discs, as well as the surface roughness and its influence on bacterial adherence. Mylar strip showed the smoothest mean surface value, followed by Permaseal, Optiguard, and G Coat Plus. Caulk had the highest mean roughness value. On comparing the surface sealants Permaseal, Optiguard had a smoother finish than the surface finished with Caulk micro polisher alone. In the present Mylar strip, Permaseal and Optiguard showed lesser than 0.2 µm, and Caulk, G Coat Plus showed higher than 0.2 µm. This finding suggested that applying surface sealants Permaseal and Optiguard reduced the average roughness (Ra) to half the initial roughness value obtained with the Caulk micro polisher.

Rizzante et al., in their in-vitro investigation, compared the surface roughness and colour stability of the restoration before and after applying various resin-coating treatments. They noted that resin coatings decreased the surface roughness of polished restorations. They stated that even while the sealant may have been removed from the surface, it may still be there at the restorative interface and in surface

gaps or microcracks, which could lead to less wear and better long-term marginal sealing.[16] Various studies have shown that sealant application improves the surface texture and reduces roughness.[17,18]

In contrast to the present study's findings, Cortopassi et al. did not find advantages over composites without coating materials. However, they opined that surface sealants could be employed as coating materials over composites.[19]

Contrary findings were noted in a study by Pietrokovski et al, who compared two polishing kits with a mylar strip as a control. Although the surface smoothness improved in one technique, the biofilm biomass measurements and bacterial counts of the groups did not differ.[20] These differences could be attributed to the difference in physical characteristics of composite resin materials used between the studies.

The study assessed two incubation times (6 and 18 hours) for intragroup comparison. Bacterial adhesion to a material surface is a two-phase process. While phase one is the first, immediate, and reversible physical phase, phase two is the time-dependent, irreversible molecular and cellular phase.[21] In our study, at 6 hr incubation time of clinical strains G1 and G3, G4 displayed similar CFUs, which were lesser than G2. G2 and G5 had similar characteristics. For Clinical Strains, at 18-hour incubation, Groups G1, G3 and G4 showed similar bacterial characteristics, which fared much better than G5. For standard strains at 6 hours incubation G1, G3 and G4 showed similar bacterial characteristics, while G5 had statistically significant greater CFUs. With the 18-hour incubation of the Standard strains, there was no statistical significance

between the groups, suggesting that the adhesion of Streptococcus mutans to the surface sealants may be time-dependent. The mean colony-forming units increased between 6 and 18 hr in the Caulk micro polisher.

S.mutans cells secrete glucosyltransferase exoenzymes that can attach to the tooth and microbial surfaces and encourage bacterial accumulation.[22] Secretion of glucans was noted predominantly in the clinical isolate groups with a slimy layer over the colonies. The results of Standard strains at 6-hour incubation were similar to the clinical strains, yet the slime layer's voluminous secretion was not noted with Standard strains. The present findings of the study suggest that the initial Streptococcus mutans adhesion decreased significantly in PS and OG surface sealants groups.

In vitro study by Kim and Kwon examined Streptococcus mutans adherence on Filtek Z250 composite resin covered with three surface sealants - PS, OG and Fortify Plus. The molds finished with Mylar strips, and those polished with a PoGo polishing disc served as controls. The surface treated with sealants had fewer voids, cracks and other microstructural flaws. No significant differences were noted in surface roughness amongst the sealant-coated groups. The sealant group also demonstrated lesser S. Mutans adhesion. These findings are in agreement with that of our study.[2]

Similar to our study, Mohktar et al., in their study on CAD/CAM resin blocks, found an appositive correlation between roughness and bacterial adhesion after 24 hours of incubation.[23] Topcu and co-researchers, in their study of S. Mutans adhesion to composite resin-based interim crown materials, noted that applying surface sealant material decreased the Ra values. They also noted that bacteria tend to aggregate in high surface roughness areas, which was observed in our study too.[24]

According to the results of this in vitro investigations, using surface sealants Permaseal and Optiguard and Mylar strips can help reduce surface roughness and the propensity for S.mutans to adhere to composite resin.

CONCLUSION

The arrangement of physical-chemical aspects with various chemical properties and distinct types of components make resin-based composite surfaces non-homogeneous. Further operatory techniques also influence polymerisation. Inadequate polishing and finishing of dental restorations can result in plaque buildup, gingival irritation, discolouration, cavities and aesthetic degradation. It is possible to conclude, within the constraints of this in vitro study, that polishing techniques positively affected the surface roughness of the investigated resin composites. More in situ research is required to understand the function and mechanism of each surface parameter on oral biofilm growth.

Limitations of the study

Since there are many various types of bacteria in the oral cavity, the polishing systems under study might be affected differently in an in-situ oral environment. Moreover, polishing systems have a history of deterioration. Long-term research can shed more light on the chemical and physical properties of the materials.

REFERENCES

1. Vishwanath S, Kadandale S, Kumarappan SK, Ramachandran A, Unnikrishnan M, Nagesh HM. Finishing and polishing of composite restoration: Assessment of knowledge, attitude and practice among various dental professionals in India. Cureus 2022; 14: e20887.
2. Kim DH, Kwon T-Y. In vitro study of Streptococcus mutans adhesion on composite resin coated with three surface sealants. Restor Dent Endod 2017; 42:39–47.
3. Pereira CA, Eskelson E, Cavalli V, Liporoni PCS, Jorge AOC, do Rego MA. Streptococcus mutans biofilm adhesion on composite resin surfaces after different finishing and polishing techniques. Oper Dent 2011; 36:311–7.
4. Zheng S, Bawazir M, Dhall A, Kim H-E, He L, Heo J, et al. Implication of surface properties, bacterial motility, and hydrodynamic conditions on bacterial surface sensing and their initial adhesion. Front Bioeng Biotechnol 2021; 9:643722.
5. Montanaro L, Campoccia D, Rizzi S, Donati ME, Breschi L, Prati C, et al. Evaluation of bacterial adhesion of

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Streptococcus mutans on dental restorative materials. Biomaterials 2004; 25:4457–63.
6. Hannig M. Transmission electron microscopy of early plaque formation on dental materials in vivo. Eur J Oral Sci 1999; 107:55–64.
7. Hahnel S, Rosentritt M, Bürgers R, Handel G. Surface properties and in vitro Streptococcus mutans adhesion to dental resin polymers. J Mater Sci Mater Med 2008; 19:2619–27.
8. Motevasselian F, Zibafar E, Yassini E, Mirzaei M, Pourmirhoseni N. Adherence of streptococcus mutans to micro-hybrid and nanohybrid resin composites and dental amalgam: An in vitro study. J Dent (Tehran) 2017; 14:337–43.
9. Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. Dent Mater 1997; 13:258–69.
10. Bürgers R, Cariaga T, Müller R, Rosentritt M, Reischl U, Handel G, et al. Effects of aging on surface properties and adhesion of Streptococcus mutans on various fissure sealants. Clin Oral Investig 2009; 13:419–26.
11. Türkün LS, Türkün M. The effect of one-step polishing system on the surface roughness of three esthetic resin composite materials. Oper Dent 2004; 29:203–11.
12. Ozgünaltay G, Yazici AR, Görücü J. Effect of finishing and polishing procedures on the surface roughness of new tooth-coloured restoratives: Finishing/polishing effects on surface roughness. J Oral Rehabil 2003; 30:218–24.
13. Huang R, Li M, Gregory RL. Bacterial interactions in dental biofilm. Virulence 2011;2:435–44.
14. Yuan C, Wang X, Gao X, Chen F, Liang X, Li D. Effects of surface properties of polymer based restorative materials on early adhesion of Streptococcus mutans in vitro. J Dent 2016; 54:33–40.
15. Cazzaniga G, Ottobelli M, Ionescu AC, Paolone G, Gherlone E, Ferracane JL, et al. In vitro biofilm formation on resin-based composites after different finishing and polishing procedures. J Dent 2017; 67:43–52.
16. Rizzante FAP, Bombonatti JSF, Vasconcelos L, Porto TS, Teich S, Mondelli RFL. Influence of resin-coating agents on the roughness and color of composite resins. J Prosthet Dent 2019; 122:332.e1-332.e5.
17. Bertrand MF, Leforestier E, Muller M, Lupi-Pégurier L, Bolla M. Effect of surface penetrating sealant on surface texture and microhardness of composite resins. J Biomed Mater Res 2000; 53:658–63.
18. Attar N. The effect of finishing and polishing procedures on the surface roughness of composite resin materials. J Contemp Dent Pract 2007; 8:27–35.
19. Cortopassi LS, Shimokawa CAK, Willers AE, Sobral MAP. Surface roughness and color stability of surface sealants and adhesive systems applied over a resin-based composite. J Esthet Restor Dent 2020; 32:64–72.
20. Pietrokovski Y, Zeituni D, Schwartz A, Beyth N. Comparison of different finishing and polishing systems on surface roughness and bacterial adhesion of resin composite. Materials (Basel) 2022; 15:7415.
21. Katsikogianni M, Missirlis YF. Concise review of mechanisms of bacterial adhesion to biomaterials and of techniques used in estimating bacteria-material interactions. Eur Cell Mater 2004; 8:37–57.
22. Palmer SR, Ren Z, Hwang G, Liu Y, Combs A, Söderström B, et al. Streptococcus mutans yidC1 and yidC2 impact cell envelope biogenesis, the biofilm matrix, and biofilm biophysical properties. J Bacteriol 2019; 201.
23. Mokhtar MM, Farahat DS, Eldars W, Osman MF. Physico-mechanical properties and bacterial adhesion of resin composite CAD/CAM blocks: An in-vitro study. J Clin Exp Dent 2022; 14: e413–9.
24. Eslemez Topcu E, Şahin O, Köroğlu A, Cömert F, Yilmaz B. Surface roughness and Streptococcus mutans adhesion on surface sealant agent coupled interim crown materials after dynamic loading. BMC Oral Health 2022; 22:299.