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Comparative evaluation of Surface Roughness and Microbial Adhesion of Alkasite resin based composite Vs bioactive Giomer after simulated toothbrushing: An In Vitro study

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Aim: The present study aimed to evaluate the surface roughness and microbial adhesion of Alkasite resin-based composite versus bioactive Giomer after simulated toothbrushing.
Material and Methods: A total of forty-eight disc shaped specimens of giomer and alkasite resin based composites were set using Teflon split mold (1.5 × 8.5 mm) (n=6), finished and polished then the top surface of the specimens was subjected to simulated toothbrushing immediately. The specimens were randomly allocated into two groups; twenty-four each from both materials, for surface roughness (Ra) and microbial adhesion assessment then each group was subdivided into two groups according to time of assessment. The surface roughness was tested immediately (T1) and after three months of storage in distilled water (T2) by profilometer in micrometres. Microbial adhesion was tested after 24hours (Ta) and 48hours (Tb) of incubation using colony forming units. Selected samples from each subgroup were examined to monitor the surface before and after storage time using Scanning Electron Microscopy (SEM). Data were analyzed and tabulated using two-way ANOVA. Bonferroni correction was used for adjusting P-values for multiple comparisons. Coefficient Correlation analysis was done using Spearman's rank-order correlation. The significance level was set at ($p<0.05$).
Results: Alkasite showed a statistically significant higher surface roughness and microbial adhesion than Giomer at different times ($p = 0.001$).
Conclusions: Giomer had better performance in surface roughness and bacterial adhesion than Alkasite. Bacterial adhesion is strongly dependent on the surface roughness of restorations.

Keywords: Alkasite, Bacterial adhesion, Giomer, Surface roughness, Toothbrushing.

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Introduction

The emergence of innovative hybrid restorative materials combining the beneficial features of composite and glass ionomer, including mechanical strength, esthetics and high bond strength of resin composites , along with the self-adhesive nature and ion-releasing properties inherent in GICs has given rise to resinous self-adhesive versions of traditional GICs known as resin-modified glass ionomer cements (RM-GICs), along with ion-releasing but not self-adhesive resin composites such as compomers and giomers. [1] Recently, one of those hybrid composites available in the market was Alkasite Cention N, Ivoclar-Vivadent, which helps in preventing demineralization and enables enamel remineralization by the ability of releasing ions as fluoride and calcium ions from the inherent highly alkaline fillers. [1, 2]

A novel class of bioactive materials, known as "Giomer," has been introduced. These materials are formulated using surface pre-reacted glass ionomer (S-PRG) particles as their key component which facilitate the release of fluoride and other ions, while their outer shell acts as a protective barrier, shielding the core structure from detrimental moisture effects. Moreover, laboratory studies demonstrated that this technology facilitates remineralization, effectively prevents demineralization, and also inhibits the growth of cariogenic bacteria. There are limited studies available about the effect of prophylaxis procedures on giomers. [3]

Surface roughness (R_a) is considered an important surface property that affects esthetic appearance, secondary caries and periodontal diseases and recognized as the high clinical relevance parameter that contributes to biofilm formation above the critical threshold of 0.2 micrometres, as it offers a greater surface area for bacteria to adhere to and also shields them from mastication force and saliva flow. It is influenced by the size, distribution, volume of the fillers in the restorative material. Therefore, numerous studies have indicated that increased surface roughness correlates with higher levels of biofilm formation and bacterial adherence. [4-6]

According to the literatures, regular tooth brushing can impact the longevity of restorative materials because abrasion during brushing may lead to changes in the material's surface, gloss, and can promote plaque retention resulted from the significant increase in surface roughness as during abrasion, the resin matrix encompassing filler particles is typically the initial component to wear out in composites. This process results in the exposure of fillers and the formation of irregularities or bumps on the surface that result in a roughened surface. [7-9]

The use of ion-releasing restorative materials often triggers concerns regarding the potential dissolution of functional filler particles on subjecting to an aqueous environment. This dissolution could lead to the formation of voids and increase water sorption, consequently exacerbating further dissolution and increase surface roughness. [10]

Owing to lack of enough knowledge about recent bioactive materials, the current study was conducted to evaluate the surface roughness and microbial adhesion of Alkasite resin based composite VS bioactive Giomer after simulated toothbrushing. The null hypothesis of the present study was that there would be no discernible difference in the surface roughness or microbial adhesion of Alkasite resin based composite and bioactive Giomer after simulated toothbrushing.

Materials and Methods

Materials:

The Materials used, their specification, composition, manufacturer and lot number are listed in table (1).

Table 1: The Materials used, their specification, composition, manufacturer and lot number

Materials	Specification	Composition	Manufacturer	LOT no.
Giomer restoration material with Surface pre-reacted glass (Beautifil II) light cured Shade (A2)	Nanohybrid radiopaque bioactive restorations.	Matrix : Bis-GMA, UDMA, Bis MPEPP, TEGDMA Fillers: S-PRGfiller containing fluoroboroaluminosilicate glass. Filler loading: 83.3 wt% (68.6 vol%) particle size range: 0.01–4.0 μm; mean size:0.8 μm	SHOFU Dental GmbH, Japan. www.shofu.com	032114
Alkasite (Cention forte) self cured Shade (A2) intervention	Radio opaque bioactive self-cured bulkfill-RBC, with a optional light-cure.	Matrix : UDMA- DCP, PEG-400 DMA Fillers: Ca-fluorosilicate glass, Ba-Al silicate glass, copolymer, Ca-Ba-Al fluorosilicate glass, (alkaline) glass filler, ytterbium. Filler loading 75% wt%_ 61 vol% particle size range (0.1–35 μm)	Ivoclar Vivadent Inc., NY, USA www.Ivoclar.com	ZL08SV

Methods:

Study design:

An in-vitro study was conducted at the Conservative Dentistry Department, Faculty of Dentistry, October 6 University, Egypt, spanning from October 2023 to January 2024. Disc-shaped specimens were randomly assigned to four groups using a computer-generated randomization tool (www.random.org) with a 1:1 allocation ratio. The study protocol received approval from the Council of the Conservative Dentistry Department and underwent ethical review by the Research Ethics Committee of the Faculty of Dentistry, October 6 University on January 9, 2023 (Approval No. RECO6U/2-2023). The present study aimed to evaluate the surface roughness and microbial adhesion of Alkasite resin-based composite versus bioactive Giomer after simulated toothbrushing.

Sample size calculation:

A power analysis was conducted to ensure sufficient power for applying the statistical test in surface roughness and bacterial adhesion between different groups. By selecting an alpha level of 0.05 and a beta of 0.2 (resulting in a power of 80%), the anticipated sample size (n) was determined to be 48 samples in total, so samples of each subgroup will be (6). Georgiev G.Z., "Sample Size Calculator" was used for Sample size calculation. [11] (Figure 1)

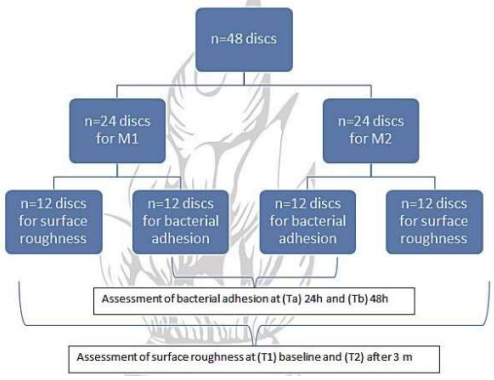

Figure 1: A flow diagram for the study groups.

Preparation of the specimens:

A total of fourty-eight disc of giomer (M1) as a comparator and alkasite (M2) as an intervenor, resin-based composites were prepared in a Teflon split mold of 1.5 mm thickness and 8.5 mm in diameter to ensure the standardization of dimensions of each disc and allow appropriate surface area of material to be finished and polished, [11,12] then subjected to simulated toothbrushing. We allocated the specimens randomly to two groups; twenty-four each from both materials, for surface roughness (Ra) and microbial adhesion assessment then each group was further divided into two subgroups in relation to time of assessment. The surface roughness was tested immediately (T1) and after three months of storage in distilled water (T2) by profilometer in µm. Microbial adhesion was tested after 24hours (T_a) and 48hours (T_b) of incubation using colony forming units. For Giomer specimen's preparation, over a thin glass slide the mold was placed against a celluloid strip and the material was carefully placed with a gold-plated applicator into the mold and the top surface of the specimen was covered by another celluloid strip with glass slide to remove any excess material and ensure the creation of a smooth, flat surface. This served to eliminate the layer of oxygen inhibition that forms on the surface during the material polymerization.[11,13] The Specimens polymerization was done using a Woodpecker Light Cure I LED for twenty seconds with a wavelength range of 385 nm to 515 nm and light intensity of 2300mw/cm2.[11,14] For alkasite specimens, the cention capsule was mixed then the material was steadily injected to the mold and adapted using gold-plated applicator and excess material removal was done as the aforementioned for giomer. A self-curing mode was followed for polymerization of samples by leaving it for 4-5 minutes in accordance with the manufacturer's

guidelines.[12,15] Each specimen's bottom surface was labelled with a permanent red marker.

Finishing and polishing of the specimens:

After polymerization of the specimens, they were extruded from the mold then were finished and polished using Sof-Lex spiral wheel kit to effectively eliminate the resin-rich layer which can't be removed by using only Mylar strip, this was done under wet condition using syringe of distilled water. [14, 16] The specimens were then stored in labelled airtight containers containing 20 ml distilled water before brushing procedure for 24 hours at 37°C to complete the setting and mimic the first day of service for materials under oral conditions. Moreover, they would not take up dentifrice slurry during tooth-brushing as they would get hygroscopic expansion [17-19]

Simulated toothbrushing:

A custom-made machine was fabricated to simulate the brushing mechanism. The machine is classified as a reciprocating machine, which transforms rotational motion to linear motion. The back-and-forth motion of the machine across the resin based composite (RBC) surface help to ensure uniform brushing of the entire surface to all the specimens and was transmitted to the toothbrushes through 3 horizontal shafts above the level of the specimen holder by 0.5 mm to ensure that the toothbrush is in contact with the specimen and not the specimen holder. The tooth-brushing machine was accomplished with horizontal actions of the toothbrush using a weight of 200 gm and a travelled course of 2 cm. The rotation was 280 cycles/min, the total time of tooth brushing was of 18 min with total 5,000 cycles which represents 6 months of tooth brushing. Soft toothbrush head was substituted with every 2000 cycles, while the slurry mixture (dentifrice (Signal Anti-Caries RDA 60-80), distilled water) was applied by a syringe every 5 minutes of the testing time. To resemble tooth brushing in the oral cavity, dentifrice and distilled water were used with ratio of 1:1. [20-22]

Post preparation storage of specimens:

After brushing twenty-four specimens, from both materials, were immediately incubated for 24 hours and after 48 hours. [23] The other twenty-four specimens were divided separately as follows: half of the specimens were tested immediately for baseline results while the other were stored in distilled water for 3 months at 37°C in labelled containers for each subgroup to replicate the neutralizing effect of the saliva without incorporating its components.[24]

Surface Roughness assessment:

The evaluation of roughness of samples obtained by surface contact profilometer manufactured by Mitutoyo Japan, as is most commonly used in evaluating surface characteristics. Roughness was assessed at three points located centrally of each specimen, and the overall roughness value (Ra1) was determined by the average of measurements. The profilometer underwent calibration to ensure compliance with standards before commencing each new measuring session. Following storage in distilled water for three months, the second roughness assessment (Ra_2) was accomplished, as done before. [7, 25] Data were allocated, tabulated and statistically analysed.

A representative sample of each subgroup were examined using Scanning electron microscope (SEM) (Model FEI Quanta 3D 200i) linked to EDX Unit (Energy Dispersive X-ray Analyses/thermofisher pathfinder) (at x250 magnification) for further evaluation of surface characteristics at different storage times and to confirm the findings obtained by contact profilometer. [6, 7]

Bacterial adhesion assessment:

S. mutans strain ATCC 25175 was obtained from Microbiological Resources Centre (Cairo Mircen). Brain heart infusion (BHI) agar was used for seeding S. mutans,

and then incubated for 24 h at 37° C in a 10% CO_2 incubator. After incubation, the bacteria were suspended in phosphate-buffered saline, PBS. A microbial concentration of approximately 1.5 × 10^8 cells/ml was obtained by adjusting the suspension to 0.5 on the McFarland scale. The samples were sterilized before being placed into a sterile 24-well polystyrene tissue culture plate, one sample in each well. Subsequently, 2 mL of the previously prepared bacterial suspension was applied to each sample surface then incubated separately for 24 hours and 48 hours at 37°C in a CO2 incubator, with dedicated specimens for each time point. Following incubation, each sample was removed from well and sterile PBS was used gently to rinse the samples twice. They were then individually placed in tubes of 50-mL containing 1.5 mL PBS and sonicated for 30 s to disperse the adherent bacteria. Afterward, the samples were detached from the suspension and serial dilutions were performed. To end with, BHI agar plates were used for seeding aliquots of 0.1 mL from each tube in duplicates. The samples were incubated after being spread over the plates at 37° C for 48 h in a CO_2 incubator then Streptococcus mutans colonies were visually enumerated and mean values were calculated in (CFU/mL). [2, 23, 26]

Statistical analysis:

Numerical data were presented as mean and standard deviation (SD) values. Normality and variance homogeneity assumptions were validated by using Shapiro-Wilk's and Levene's tests respectively. Surface roughness data were normally distributed while bacterial adhesion data were log-transformed to achieve normality. Both data had homogenous variances. They were analyzed using two-way ANOVA followed by simple main effects comparisons utilizing the error term from the two-way model. Multiple comparisons were set by adjusting P-values by Bonferroni correction. Spearman's rank-order correlation coefficient was used for correlation analysis. The significance level for all tests was set at $p<0.05$. Statistical analysis was performed using R statistical analysis software version 4.3.2 for Windows.

Results

Regarding Surface Roughness,

A statistically significant difference with increased surface roughness was found at the immediate assessment (T1) for alkasite (M2) than giomer (M1) ($p<0.001$). The same statistically significant difference with increased surface roughness at 3 months (T2) also found for alkasite (M2) than giomer (M1). ($p<0.001$). ($p<0.05$). Regardless of measurement time, alkasite (M2) samples had significantly higher roughness than giomer(M1), ($p<0.001$). ($p<0.05$). The roughness values of giomer (M1) after 3 months (T2) were increased without statistically significant difference than baseline (T1) ($p=0.098$). ($p>0.05$) while alkasite (M2) showed a statistically significant difference with an increase in surface roughness values of after3 months (T2) than baseline (T1). ($p<0.001$).($p<0.05$). (table2).

Table 2: Different materials and times intergroup comparisons, mean and standard deviation (SD) values of surface roughness (Ra) in (µm).

Material / Time	Surface roughness (Ra) (Mean±SD)		p-value
	M1	M2	
T1	0.37±0.09	0.74±0.00	<0.001*
T2	0.48±0.11	1.02±0.04	<0.001*
p-value	0.098ns	<0.001*	

*; significant ($p<0.05$) ns; non-significant ($p>0.05$).

Regarding bacterial adhesion

A statistically significant difference with increased bacterial adhesion was found at the 24h (T_a) for alkasite (M2) than giomer (M1). ($p<0.001$).($p<0.05$). The same

statistically significant difference with an increase regarding bacterial adhesion at the 48h (T_b) also found for alkasite (M2) than giomer (M1) (p<0.001). (p<0.05). Regardless of measurement time, bacterial adhesion measured in alkasite (M2) was significantly higher than that of giomer (M1) (p<0.001). (p<0.05). A statistically significant difference with increased bacterial adhesion in giomer (M1) was found at 48h (T_b) than 24h (T_a). (p<0.001).(p<0.05). There was slightly dropped bacterial count with no statistically significant difference in bacterial adhesion of alkasite (M2) for 48h (T_b) than 24h (T_a). (p = 0.257). (p<0.05). (table3).

Table 3: Different materials and times intergroup comparisons, mean and standard deviation (SD) values of log bacterial count.

Material / Time	Log bacterial count (Mean±SD)		p-value
	M1	M2	
Ta	12.32±0.08	14.62±0.15	<0.001*
Tb	12.95±0.07	14.54±0.10	<0.001*
p-value	<0.001*	0.257ns	

*; significant (p<0.05) ns; non-significant (p>0.05).

Correlation between surface roughness and bacterial adhesion

A strong positive statistically significant correlation was found between surface roughness and bacterial adhesion (p<0.001). (p<0.05). as correlation coefficient between roughness-bacterial adhesion was 0.750 (0.496:0.885) with Confidence interval 95% (CI).

Scanning Electron Microscope (SEM):

Corresponded to the results of roughness, samples evaluation by SEM was in consistency with the roughness results that alkasite had higher Ra at different storage times. The SEM images (at x250 magnification) illustrated the surface texture of tested materials before and after storage time are shown in Figure (2).

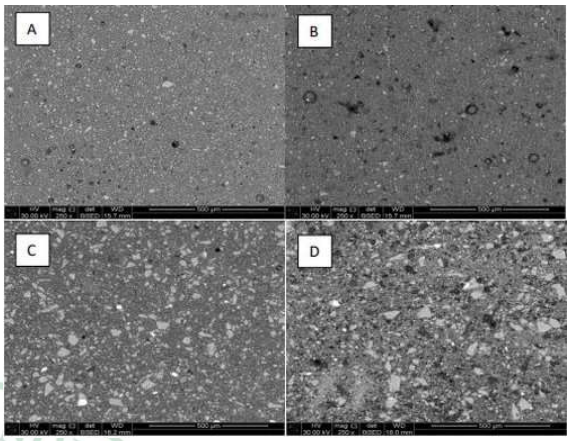

Figure 2: SEM image of the specimens of giomer at T1 (A), giomer at T2 (B), alkasite at T1(C), alkasite at T2 (D).

Combination of exposure of inorganic filler particles which distributed in different shapes and sizes, loss of some fillers and resin matrix wear as a result of toothbrushing process and storage was detected as voids, grooves and facets appearance. The effect of aging after 3 months caused an increase in dislodgment of fillers in alkasite more than giomer as a result of dissolution by water.

Discussion

The ongoing advancements and adjustments in filler technology and composite formulations, such as varying filler content, size, shape, and interparticle spacing, along with the type of monomer used and improved filler-matrix bonding, have resulted in a favorable long-term clinical performance and positively affect surface roughness. [5]

In accordance with (ISO 4287:1997, 2015), surface roughness (SR) is delineated as one among various parameters employed to characterize the deviation of a surface from an ideal flatness because of the presence of finer irregularities found in surface texture, which are inherent in the materials or raised during the manufacture procedure. It plays a significant role in accumulation of dental

plaque with critical threshold 0.2 µm as the value for bacterial plaque retention. [16]

The accumulation of biofilm on restorative material surfaces promotes the development of secondary caries and periodontal inflammation that represents a crucial factor influencing restoration longevity. [27] Materials differ in microbial adhesion in accordance with their properties including chemical composition and surface characteristics. [26]

Cention Forte ® (CF) is the successor of Cention N® in hand-mixing formula. Cention N, marketed as RBC containing alkaline fillers named alkasite with an improved polymerization system and offers supplementary ion-releasing or bioactive properties. Both Cention and Giomer are considered bioactive substances since they utilize reactive fillers that don't necessitate the use of acids for their activation. Giomers employ S-PRG FAS fillers, while Cention N utilizes calcium fluorosilicate fillers. [1, 12]

The choice of bristle type and toothpaste significantly influences the rate at which composite resin surface deteriorates so signal Anti-Caries with RDA 60-80 (moderate abrasive) and soft bristle brush were used. [21] Since a toothbrush should be replaced after 45 days toothbrush head was substituted every 2000 cycles.[7] In vitro aging methods as water storage explain the materials deterioration rate and properties within the oral environment. [24, 28]

The data of roughness gathered in this study yielded satisfactory outcomes, revealing statistically significant distinctions between the materials examined. The results of this study suggested the rejection of the null hypothesis.as giomer had significant lower surface roughness values and significant lower bacterial adhesion. However, limited studies have been performed for surface roughness evaluation of giomer and alkasite after brushing, the present study outcomes were consistent with who compared the Ra of giomer and alkasite and discovered Ra values for giomer is the lower than alkasite. [14]

After tooth brushing at (T1), giomer showed significant lower roughness than alkasite. This could be due to smaller size filler particles in giomer than that in alkasite one with higher filler load, thus providing a smoother surface. The findings are supported by Previous investigations [23, 24, 29] reported that alkasite exhibits elevated surface roughness compared to conventional and bulk-fill nanocomposites and smoother than an RMGIC. Their explanation was that when larger and irregular filler particles are lost, it results in larger voids, consequently increasing surface roughness. Alkasite with its larger and coarser filler particle size, ranging heterogeneously from 0.1 to 35 µm, exhibits higher surface roughness. According to the study SEM images giomer had smaller spaces size and homogenously distributed, while alkasite distributed irregular and had larger voids even after storage in consistence with a previous study [18] showed that SEM microphotographs of Beautifil II (0.01–4.0 µm) showed no scratches and mostly smoother surfaces and exhibited the smallest change in surface roughness than different microhybrid and nanohybrid RBCs.

The higher roughness of akasite is also believed to result from self-curing of the material which agreed with the findings of a previous studies [10,19] stated that allowing Cention to self-cure without the additional light-curing leads to reduced material polymerization and higher solubility, thereby resulting in increased surface roughness (Ra).

After 3 months of immersion in distilled water, giomer continue to show significant lower roughness than alkasite, this may be owing to the aforementioned reasons (smaller filler particle size of giomer and curing mode of alkasite) beside that, the surface pre-reacted glass (S PRG) fillers in giomer, was found to be less susceptible to

erosion and it had higher filler content compared to alkasite with higher resistance to degradation and large filler size is related to higher formation of pores. These findings concur with previous investigations [10, 24, 30, 31] claimed that when RBCs are exposed to water, there is a swift release of unreacted monomers within the initial 1–4 weeks, resulting in chemical degradation via hydrolysis, caused by the hydrolytic degradation of the bond connecting the silane to the filler particles, gradually alters the microstructure of the composite bulk by creating voids/pores then the water absorbed by the resin fills the voids and pores, as well as the spaces between the polymer chains and (UDMA)-based resins (the basic monmer in alkasite) show more degradation in aqueous environment than (Bis-GMA) resins (the basic monmer in giomer). Thus, higher solubility and water sorption of alkasite than giomer lead to higher chemical degradation in alkasite. In contrast to a previous study discovered that Beautifil II has large filler particles and high-water sorption and the release of fluoride ions from this material suggested creating vacancies on its surface.[8]

After 3 months of immersion in distilled water giomer and alkasite showed increase in Ra compered to baseline, but giomer showed no significant difference. This could be due to the composition of giomer that delay the diffusion of the material in water. These findings are in line with a previous study discovered that Beautifil-II exhibited robust stability, possibly due to the unique structure of the S-PRG fillers and the surface-modified layer, which effectively shields the glass core, thereby safeguarding it from the detrimental impact of moisture.[32]But conversely, another study [11] stated that the high water sorption and solubility of Beautifil II led to swelling of the resin matrix and eventual filler de-bonding, consequently increasing surface roughness. While alkasite showed significant increase in Ra compared to baseline this could be as a result of rapid breakdown of its matrix with large filler size release forming large number of pores over time.[19, 29]

In the current study, results showed that both materials decreased bacterial count than the beginning strain, this could be due to the fact that the two materials are bioactive which act against certain bacteria by the ability of fluorine release in giomer and alkaline glass in CF releases (OH- and Ca2+) ions to prevent the demineralization and neutralize the acidic environment. As cention N consistently released fluoride ions in acidic and neutral pH environments across all time intervals. [2] This release has the potential to notably decrease Streptococcus mutans levels in plaque by diminishing the capability of S. mutans to metabolize sucrose.[29, 33] Thus despite the presence of rough surfaces, the count of Streptococcus mutans can be elucidated by the potentiation of ion release facilitated by these restorative materials.

The current study showed that at different times, 24h and 48h, giomer had significant lower bacterial adhesion than alkasite. This could be due to that the SR of giomer is lower than alkasite and fluoride release which is higher in giomer than alkasite. In accordance with previous studies[34, 35] showed that the first stage of bacterial colonization commences at surface irregularities, providing protection against shearing forces. Therefore, restorations with elevated surface roughness facilitate the adhesion of glucans and bacterial colonization. Out of the 78.4% filler content in alkasite, only 24.6% of the resulting material contributed to the release of fluoride ions resulted in smaller amount of fluoride ions, while that S-PRG fillers in giomer release ions such as water-soluble sodium (Na+), which can trigger the release of five additional ions, including borate ions (BO3-) beside fluoride, aiming to hinder bacterial adhesion.[29, 36]

There was a significant increase in bacterial colonies count on giomer samples at 48h than 24h, this could be due to the quantity of released fluoride notably decreased following the brushing simulation over time and the material chemical composition, specifically the monomer configurations within the resin matrix could eliminate the antibacterial activity as a function of time. The amount of fluoride released from resin-modified glass-ionomer materials and Giomers exhibited an initial burst effect that diminished gradually. The brushing simulation led to a statistically higher biovolume of bacteria due to the gradual decrease in fluoride ions post-simulation. Additionally, the released TEGDMA heightened the bacterial pathogenicity more than other monomers.[6, 23]

Alkasite showed a non-significant decrease in bacterial count at 48h than 24h, this may be explained by the alkaline glass filler, specifically calcium fluoro-silicate glass, is accountable for the significant release of ions from CF and the ongoing release of hydroxide ions plays a role in regulating the the biofilm PH. Agreed with opinion of recent study stated that CN significantly exhibited high levels of released F+ and Ca2+, potentially leading to reduced levels of S. mutans colonization with it. [23]

There was a significant correlation between surface roughness and bacterial adhesion Contrast with the findings of previous investigations discovered that Surface roughness did not affect S. mutans adhesion, and the increase in surface roughness was not directly correlated with bacterial adhesion.[37-39]

This study's limitations include that the present in vitro study correlation is done only to clinical situations where there are accessible and relatively flat restoration surface. The impact of additional mediums like artificial saliva, acids, ethanol, and various aging procedures such as thermocycling should be assessed. It's important to note that in vivo conditions may alter the change in surface roughness resulting from aqueous aging, due to the presence of salivary pellicle, which is not accounted for in this in vitro design.

Conclusions

Within the scope of this in vitro study, it can be concluded that Giomer had better performance in surface roughness and bacterial adhesion than Alkasite resin composite and bacterial adhesion is strongly dependent on surface roughness of restorations. that's why further clinical trials are recommended to assess clinical presentation of alkasite with different conditions. Surface roughness represents a significant key factor in longevity of restorations that affect the plaque accumulation, leading to recurrent caries and the effect of ageing on surface degradation and roughness is material dependent.

Declaration:

Funding

No funding was received for this work. (Self-funded by the corresponding author).

Data availability

The data that support the findings of this study are available on request from the corresponding author (Wessam Fathy Elsisy), Wessamfathy.dent@o6u.edu.eg

Competing interests

The authors declare that they have no known 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 Conservative Dentistry Department and underwent ethical review by the Research Ethics Committee of the Faculty of Dentistry, October 6

University on January 9, 2023 (Approval No. RECO6U/2-2023).

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