Effect of desensitising toothpaste on brushing simulation on the surface roughness of two commercially available glass ionomer cements - An in vitro study

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Abstract :

Introduction: Glass ionomer cements have been widely used in dentistry due to a large number of good features. In restoration procedures, a surface character, such as roughness, can determine the quality and the clinical behavior of the restoration material. The aim of the study is to evaluate the effect of desensitising toothpaste on brushing simulation on the surface roughness of two commercially available glass ionomer cements.

Materials and methods: Eight GIC samples were prepared and divided into two groups. Group 1 was samples made from the brand D Tech and group 2 was samples made from brand GC Gold label. Glass ionomer cement samples were then placed in the brushing simulator (ZM3.8 SD Mechatronik) for eight hours which refers to 30,000 cycles. Brushing was done using a desensitising toothpaste. Profilometric analysis was carried out to check the surface roughness of glass ionomer cement material before and after brushing simulation. The surface roughness was checked by using the stylus profilometer. Ra, Rq and Rz values were obtained and tabulated accordingly.

Results: Independent t test done. Significance values for Ra, Rq and Rz values were 0.228, 1.000, 0.840 respectively. This difference was not statistically significant, It was observed that after brushing simulation there was an increase in surface roughness of both the D tech and GC gold label brands of glass ionomer cement.

Conclusion: On comparing two brands, D tech showed higher surface roughness than GC gold label after brushing simulation with a desensitising toothpaste.

Keywords: Glass ionomer cement, Brushing simulation, Surface roughness, Profilometric analysis, Innovative measurement

INTRODUCTION:

Glass ionomer cements are used in restorative dentistry for a variety of qualities such as adhesion to enamel and dentin in humid conditions, less volumetric contraction, preservation

of the pulp, coefficient of thermal expansion similar to dentin, low solubility in the oral environment and release of fluoride, that can aid the affected dentin remineralization process (1). Nevertheless, their sensitivity to moisture, low mechanical strength and low wear resistance makes glass ionomer restorations usually less durable. These materials have clinical limitations such as prolonged setting reaction time, moisture sensitivity during initial setting, dehydration, and rough surface texture, which can hamper mechanical resistance.(2) In restoration procedures, a surface character, such as roughness, can determine the quality and the clinical behavior of the restoration material.(3)

Smooth surfaces can influence the aesthetic aspect of restorative materials(4). On the other hand, rough surfaces can help retention, survival and proliferation of many caries-inducing microorganisms (Streptococcus mutans and Lactobacillus spp.) in the oral cavity and also favor periodontal diseases (Porphyromonas gingivalis and Actinobacillosis actinomicetemcomitans); they also favor plaque retention causing gingival irritation.(5) Although surface free energy can play a role in bacterial adhesion and retention, surface roughness overrules the influence of surface free energy. Each roughness parameter is calculated using a formula to describe the surface. Arithmetic mean roughness (Ra) is the arithmetic average of all frames of the profile filtered by measuring the length from the line of the reference profile.(6)

Particle size has been shown to play an important role in how well a material polishes. Some studies have recorded the highest values of surface roughness for the materials with larger particle sizes.(7) GIC liquid component might influence their surface roughness as well. The progressive improvements made to glass-ionomer materials since their inception have resulted in the development of improved restorative materials with high retention rates.The esthetic appearance of these materials, however, is still considered suboptimal.(8) To achieve improved esthetic results, an ideal finishing and polishing protocol should be established. The surface roughness of a restorative material is an important factor related to restoration quality and longevity.(9) Smooth, well-contoured restoration surfaces allow for proper esthetics, low gingival irritation, decreased secondary caries, and reduced plaque accumulation.(10) The aim of the study is to evaluate the effect desensitising toothpaste on brushing simulation on the surface roughness of two commercially available glass ionomer cements.

MATERIALS AND METHODS:

Two commercially available glass ionomer cements were taken for sample preparation. Eight samples were prepared and divided into two groups. Group 1 was samples made from the brand D Tech and group 2 was samples made from brand GC Gold label. The samples were manually mixed using a cement spatula and following the manufacturer's instructions, in a ratio of two scoops of powder for two drops of liquid. Afterwards, the cement was placed into a round silicone mould. To create a standardized first-class cavity, silicone molds were prepared with uniform thickness.

Profilometric analysis was carried out to check the surface roughness of glass ionomer cement material before brushing simulation. The surface roughness was checked by using the stylus profilometer (Mitutoyo SJ-310). (Figure 1) Ra, Rq, Rz values were calculated and it was tabulated accordingly. Glass ionomer cement samples were then placed in the brushing simulator (ZM3.8 SD Mechatronik) for eight hours which refers to 30,000 cycles. (Figure 2) Brushing was done using a desensitising toothpaste. Circular, clockwise and anticlockwise were the motions performed. Linear axis is 10,000, Y axis is 10,000, clockwise is 5000 and anticlockwise is 5000. This simulation is equal to three years of brushing. After brushing simulation values of Ra, Rq and Rz was again checked using a stylus profilometer. The average mean of pre and post brushing simulation using the parameters was calculated and was analysed using the SPSS software program. It was then represented in a bar chart form.

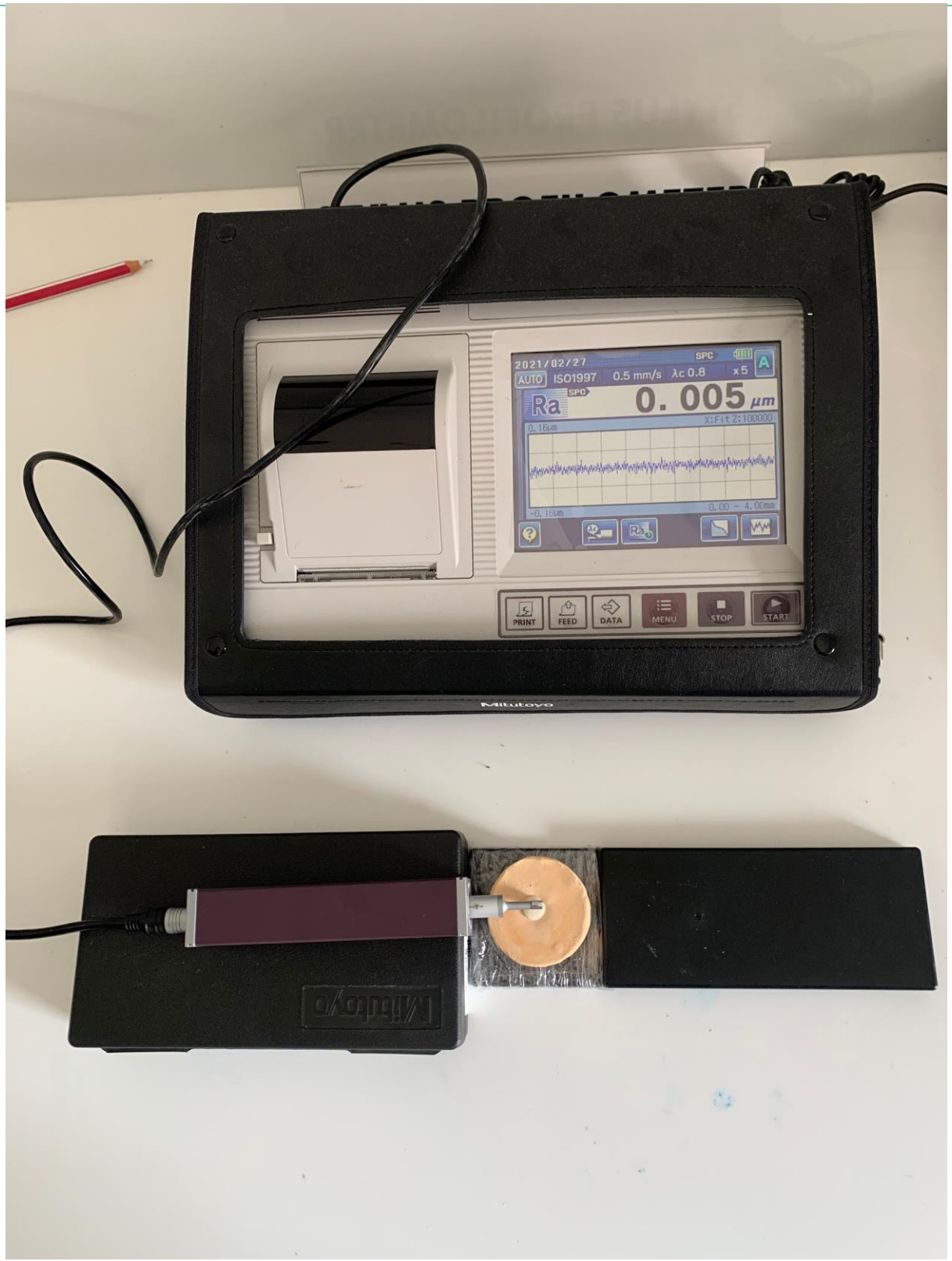

Figure 1: The image shows samples kept in a stylus profilometer for checking surface roughness pre and post brushing simulation.

Figure 2: The image shows samples placed in the brushing simulator.

RESULTS:

The surface roughness of both the glass ionomer cement Dtech (group 1) and GC gold label (group 2) pre and post brushing simulation was obtained. Independent t test was done for intergroup comparison. Table 1 represents the mean, standard deviation and significance values between the groups. Independent t test done. Significance values for Ra, Rq and Rz values were 0.228, 1.000, 0.840 respectively. This difference was not statistically significant.
D tech showed higher surface roughness than the GC gold label. (Figure 3)

Table 1 : This table represents the mean, standard deviation and significance values between the groups

Group	Roughness	Mean	Std deviation	Std error	Significance

	parameter			mean	
D tech	Ra	-0.00075	0.000500	0.000250	0.228
GC gold label		-0.00050	0.001000	0.000500	
D tech	Rq	-0.00175	0.000500	0.000250	1.000
GC gold label		-0.00125	0.000500	0.000250	
D tech	Rz	-0.01075	0.010046	0.005023	0.840
GC gold label		-0.00950	0.009849	0.004924	

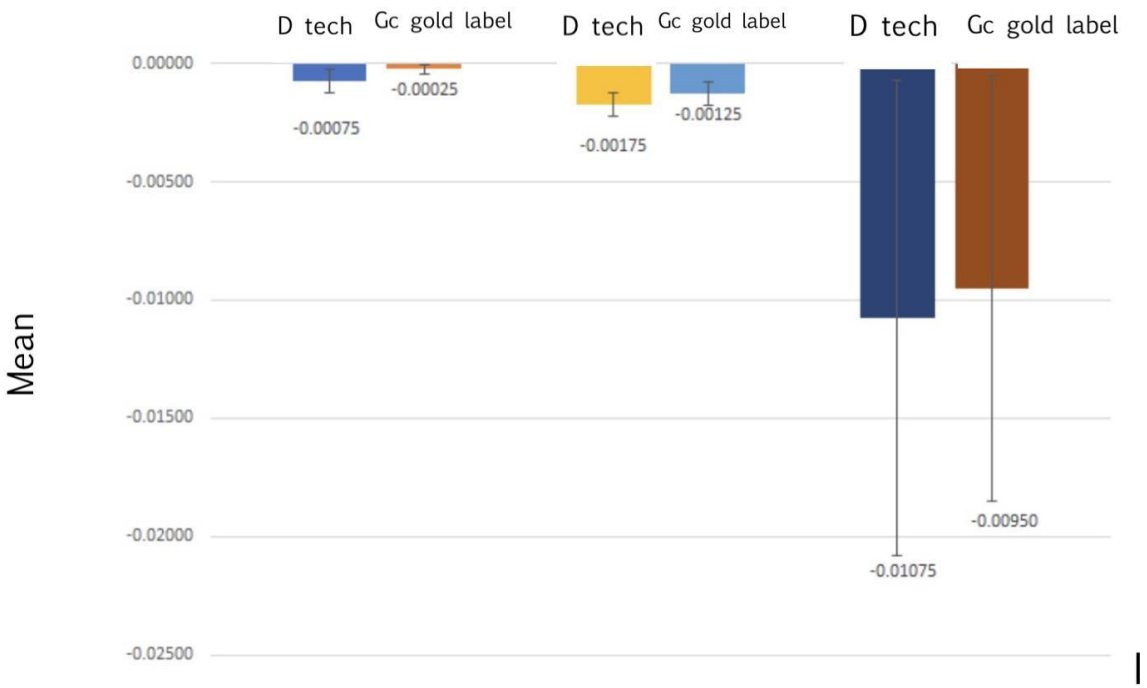

Figure 3 : This bar graph depicts the association between the type of GIC used and the mean difference in surface roughness. Blue and orange denote the Ra mean difference value of D tech and GC gold label respectively, yellow and sky blue denote the Rq mean difference value of D tech and GC gold label respectively, dark blue and brown denote the the Rz mean difference value of D tech and GC gold label respectively. D tech showed higher surface roughness than the GC gold label.

DISCUSSION:

Glass ionomer cements have been widely used in dentistry due to a large number of good features. However, lower mechanical properties and reduced wear resistance put a GIC restoration into less durable restorations. Surface roughness of GIC materials has several clinical implications and changes in surface often defined as a measure of wear of materials.(11) An increased roughness can be a predisposing factor for bacterial colonization that increases the risk of oral disease. Wear resistance and surface roughness in the oral environment are important criteria to determine and predict the clinical deterioration of restorative materials.(12) Bacterial accumulation, plaque maturation and acidity significantly increase when the surface roughness exceeds 0.2 μm, which acts on material surfaces, thus increasing caries risk.(13) From a clinical point of view, the increased surface roughness of the restored tooth surface causes accumulation of plaque, secondary caries, gingivitis and loss of periodontal attachment, and ultimately restoration loses its shine and color.(14)

Silva NM et al in a study brushed GIC samples for 15 days and then immersed in mouthrinses after the last daily brushing. The final surface roughness and weight were determined after completing the simulated tooth brushing and mouth rinsing cycles. They found an increase in surface roughness Ra values.(15) In our study also we had an increase in surface roughness Rz values after brushing simulation. The rate of abrasion depends on several factors such as the type of dentifrice, the water/dentifrice ratio, the type of brush, and the speed and pressure employed during brushing.(16) However, since in this investigation these parameters were standardized for all groups, the abrasion resistance of the studied materials seems to depend on their inherent properties.

In another study, surface microhardness and abrasion resistance after toothbrushing simulation of two conventional GIC brands was analysed. IonoStar Molar and Ketac Fil Plus Aplicap brands were used. Twenty disk-shaped specimens were subjected to toothbrushing simulation. Surface roughness, surface hardness and surface loss after abrasive procedure were evaluated using Vickers method and Vertical Scanning Interferometry. They found a decreased surface roughness and surface loss after abrasive procedures in the GIC samples.(17) This is contradictory to our study where we had an increased surface roughness after brushing simulation. The limitations of the study were that only two glass ionomer cements were included in the study for better understanding we may consider other brands too. Further studies are necessary in order to clarify the influence of the type of mixing on surface roughness, resistance of coating under continuous masticatory loads and clinical outcomes of glass ionomer cement protection.

CONCLUSION:

The findings of this study showed that after brushing simulation there was an increase in surface roughness of both the D tech and GC gold label brands of glass ionomer cement. On comparing two brands, D tech showed higher surface roughness than GC gold label after brushing simulation with a desensitising toothpaste.

CONFLICT OF INTEREST:

The authors have no conflict of interest.

ACKNOWLEDGEMENTS:

Authors thank Dr. Deepak Nallaswamy, Director, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS) for providing facilities and ideas to carry out the work.

SOURCE OF FUNDING:

The present study was supported by the following:

- Saveetha Dental College and hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai
- Sri Thirumalaipathy transport, Chennai

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