

Original Research Article

COMPARISON OF SURFACE ROUGHNESS OF TWO COMMERCIALY AVAILABLE GLASS IONOMER CEMENTS AFTER BRUSHING SIMULATION WITH HERBAL AND FLUORIDATED TOOTHPASTE - AN IN VITRO STUDY

ABSTRACT:

INTRODUCTION: Glass ionomer cement is a restorative material used in dentistry as a filling material and luting cement. Nowadays many consumers have started using natural toothpaste in order to avoid synthetic and artificial products. The aim of this study is to compare the surface roughness of two commercially available glass ionomer cements after subjecting them to brushing simulation with herbal and fluoridated toothpaste.

MATERIALS AND METHODS: Glass ionomer cements of two different brands (D- tech and gold label) were moulded into small discs of custom sizes. Their surface roughness before subjecting them to brushing simulation was recorded using Mitutoyo SJ 310 stylus profilometer. Then the glass ionomer cement pellets were mounted on die stones. 4 samples of D-tech and 4 samples of gold label were taken. The mounted samples were placed in a tooth brush simulator (ZM3.8 SD Mechatronik). The samples were subjected to 30000 cycles of brushing with standard and herbal toothpastes. After brushing simulation the GIC samples were again checked for their surface roughness using the stylus profilometer.

RESULTS: The values were recorded and analysed in the SPSS software. The obtained results from the one way ANOVA test were depicted in the form of tables and graphs. Surface roughness of D-Tech Colgate group GIC samples was increased after brushing simulation. The p-value is $0.469 < 0.05$, hence statistically not significant.

CONCLUSION: From the results obtained we can conclude that gold label brand glass ionomer cement showed less surface roughness when compared to D tech brand glass ionomer cement after brushing simulation with herbal and fluoridated toothpaste.

KEYWORDS: Glass ionomer cement, Fluoridated Toothpaste, Herbal toothpaste, Surface roughness, Stylus profilometer, Innovative measurement

Running title: Surface roughness comparison of GIC subjected to brushing with herbal and fluoridated toothpaste.

INTRODUCTION:

Glass ionomer cement (GIC) is a biomaterial used in dentistry as a filling material and luting cement. Glass-ionomer cements are based on the reaction of silicate glass-powder and polyacrylic acid, an ionomer (1). Glass ionomer cement is primarily used in the prevention of dental caries. This dental material has good adhesive bond properties to tooth structure, allowing it to form a tight seal between the internal structures of the tooth and the surrounding environment. Dental caries is caused by bacterial production of acid during their metabolic actions. The acid produced from this metabolism results in the breakdown of tooth enamel and subsequent inner structures of the tooth, if it is not diagnosed and treated at the right time (2). Glass-ionomer cements belong to the class of materials known as acid-base cements. They are based on the product of reaction of weak polymeric acids with powdered glasses of basic character (3). By bonding a restorative material to tooth structure, the cavity is theoretically sealed, protecting the pulp, eliminating secondary caries and preventing leakage at the margins. This also allows cavity forms to be more conservative and to some extent reinforces the remaining tooth by integrating restorative material with the tooth structures (4).

Toothpaste is used with a toothbrush to clean and maintain the health of teeth. Toothpaste is used to promote oral hygiene, it is an abrasive that aids in removing dental plaque and food from the teeth, assists in suppressing halitosis, and delivers active ingredients to help prevent tooth decay and gum disease (5,6). Salt and sodium bicarbonate are among materials that can be substituted for commercial toothpaste. Herbal toothpastes are made from natural ingredients and some are certified as organic (7). Nowadays many consumers have started using natural toothpaste in order to avoid synthetic and artificial flavours which are commonly found in natural toothpaste (8). Studies have shown that certain chemicals, such as triclosan are added to the toothpaste to directly inhibit the formation of plaque nevertheless with the side effects of antimicrobial resistance, teeth coloring, taste changes, and so on(9). Recently, Chinese herbal medicinal ingredients have become the focus of research because of their natural, relatively low toxicity and cultural background (10).

Abrasion is the mechanical wearing of dental hard tissue and commonly affects cervical tooth structure. This non carious tooth loss typically involves the enamel, dentine, and may involve the cementum, resulting in gingival recession. The main predisposing factors for abrasion are the toothbrushing method and the type of toothpaste used. Toothpastes contain abrasive particles, which in combination with the toothbrush, have the potential to wear tooth enamel (11). To optimise the cleaning efficiency of teeth and minimise the enamel wear it is essential to understand the science behind the tooth/toothpaste/toothbrush interface (12). The aim of this study is to compare the surface roughness of two commercially available glass ionomer cements after subjecting them to brushing simulation with herbal and fluoridated toothpaste.

MATERIALS AND METHODS:

The in vitro study was done at White lab, Saveetha Dental College and Hospital, Chennai, India. Conventional Type 2 restorative glass ionomer cement was used in the study. Glass ionomer cements of two different brands (D- tech and gold label) were moulded into small discs of custom sizes. Their surface roughness before subjecting them to brushing simulation was recorded using Mitutoyo SJ 310 stylus profilometer. (Figure 1) Then the glass ionomer cement pellets were mounted on die stones. 4 samples of D-tech and 4 samples of gold label were taken. The mounted samples were placed in a tooth brush simulator (ZM3.8 SD Mechatronik). The samples were subjected to 30000 cycles of brushing with herbal (DABUR RED) and fluoridated conventional (COLGATE) toothpastes (Figure 2). COLGATE toothpaste contains sodium lauryl sulfate, arginine, xanthan gum, zinc oxide and citrate, tetrasodium pyrophosphate, sodium fluoride, phosphoric acid and sucralose. DABUR RED toothpaste contains lavanga oil, pippali, miswak&babool extract, sunthi, pudina satva and karpura. COLGATE has more abrasiveness than DABUR RED toothpaste. Each specimen was subjected to toothbrushing with a soft bristle toothbrush. 30000 cycles of brushing simulation equals three years of brushing in the patient's mouth. After brushing simulation, the GIC samples were again checked for their surface roughness using the stylus profilometer. The values were recorded and analysed in the SPSS software. The obtained results from the one-way ANOVA test were depicted in the form of tables and graphs.



Figure 1: Image representing the measurement of surface roughness of the mounted GIC samples using a stylus profilometer.



Figure 2: Image showing the subjecting of the two brands of GIC to standard and herbal toothpastes in a brushing simulator.

RESULTS AND DISCUSSION:

In our study, 'Ra' indicates the Roughness Average of the sample, 'Rq' indicates the root mean square roughness of the sample while 'Rz' represents the point height of irregularities in the sample. Samples 1 and 2 were subjected to DABUR RED toothpaste while samples 3 and 4 were subjected to COLGATE toothpaste for both brands of glass ionomer cements. Table. 1 indicates the mean Ra values of samples of d Tech brand of glass ionomer cements and gold label brand glass ionomer cement pre and post brushing simulation. From Table. 2, the mean Rq values of samples of d Tech brand of glass ionomer cements and gold label brand glass ionomer cement pre and post brushing simulation. Table. 3 indicates the mean Rz values of four samples of d Tech brand of glass ionomer cements and gold label brand glass ionomer cement pre and post brushing simulation. The mean Rz values pre and post brushing simulation for the different brands of glass ionomer cement samples with Dabur red toothpaste and colgate toothpaste was analysed using the one ANOVA test as indicated in Figure 3. **No significant variations were seen in Ra and Rq values of the tested samples. P value for Ra parameter was 0.410 and P value for Rq parameter was 0.479 (Table 1 and 2). Surface roughness of D-Tech Colgate group GIC samples was increased after brushing simulation. The p-value is $0.469 < 0.05$, hence statistically not significant (Table 3).**

Table 1: Table representing the mean, std deviation and significance of Ra parameter pre and post brushing simulation

Groups	Mean	Std deviation	Significance
D tech- dabur red	0.00000	0.000000	0.410
D tech- colgate	0.00050	0.000707	
Gold label- dabur red	-0.00050	0.000707	
Gold label- colgate	0.00050	0.000707	

Table 2: Table representing the mean, std deviation and significance of Rq parameter pre and post brushing simulation

Groups	Mean	Std deviation	Significance
D tech- dabur red	0.00000	0.000000	0.479
D tech- colgate	0.00000	0.000000	
Gold label- dabur red	-0.00050	0.000707	
Gold label- colgate	0.00000	0.000000	

Table 3: Table representing the mean, std deviation and significance of Rz parameter pre and post brushing simulation

Groups	Mean	Std deviation	Significance
D tech- dabur red	-0.01800	0.009899	0.469
D tech- colgate	-0.02450	0.007778	
Gold label- dabur red	-0.01300	0.018385	
Gold label- colgate	-0.00550	0.002121	

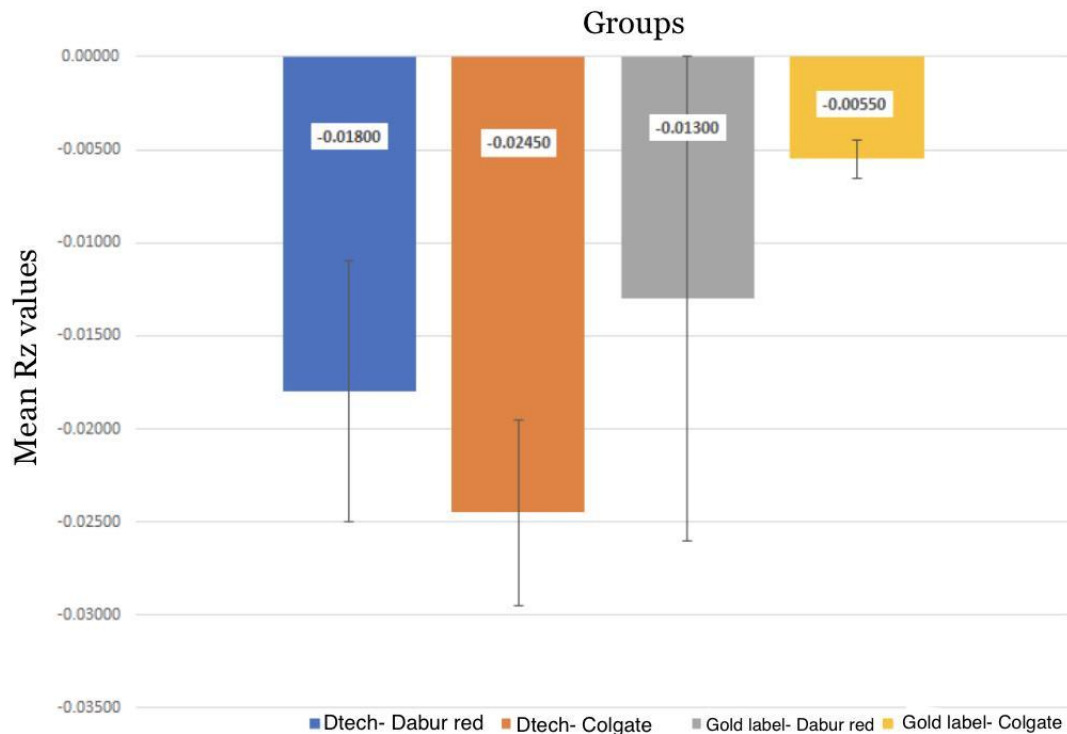


Figure.3: The bar graph shows Rz surface roughness values of D-Tech and Gold label brand of GIC pre and post brushing simulation with Dabur red toothpaste and Colgate toothpaste. Blue colour represents the mean Rz value of Dtech brand with dabur red, orange colour represents Dtech brand with Colgate, grey colour represents Gold label brand with Dabur red, while yellow colour represents Gold label brand with Colgate toothpaste. The X-Axis represents the various brands of GIC samples and the Y-axis represents the mean Rz values. Surface roughness of D-Tech Colgate group GIC samples was increased after brushing simulation. The p-value is $0.469 < 0.05$, hence statistically not significant.

Our team has extensive knowledge and research experience that has translated into high quality publications (13–22), (23–26), ((27–31), (32). From the obtained values the surface roughness of the two brands of glass ionomer cements treated with COLGATE and DABUR RED toothpastes were compared. On comparing between the two brands of glass ionomer cements we can say that gold label showed lesser surface roughness when compared to D tech after brushing simulation with colgate and dabur red toothpastes. Surface roughness is calculated by measuring the average of surface heights and depths across the surface. This measurement is most commonly shown as “Ra” for “Roughness Average” and that value is used to determine compliance of equipment with various industry standards (33). Rz is the average maximum peak to valley of five consecutive sampling lengths within the measuring length. Root mean square deviation indicates the root mean square along the sampling length. For the roughness profile, Rq is referred to as the root-mean-square roughness (34).

The irregularities present on the surface of any restorative material refers to the surface roughness of the material. These irregularities pave the way for the accumulation of microorganisms and the formation of plaque which in turn affect the quality and aesthetics of the restorative material used. In addition to this, surface roughness can impair the performance and comfort of the restorative material due to the decrease in number of smooth surfaces of the restoration (35). The surface of glass ionomer cements can be influenced by the nature, size, shape and type of particles used in its preparation and any variation in these factors can significantly increase the surface roughness of the glass ionomer cement (36). Based on a study conducted by Oya Bala et al, **the surface roughness of different glass ionomer cements was evaluated using a surface profilometer**. It was concluded that nanofiller glass ionomer cements had smoother surface finishes, post brushing simulation, as compared to resin modified and conventional glass ionomer cements. This property was attributed to its composition which varied from the conventional glass ionomer cements (37). However, all commercially available glass ionomer cements which were tested showed lower surface roughness values post brushing with fine and superfine aluminium oxide abrasives.

In order to overcome the surface roughness characteristics of glass ionomer cements certain precautions have to be administered during its manipulation. Avoiding the presence of air bubbles during incorporation of the powder and liquid can help in elimination of cracks and deformities on the surface. Further, the viscosity of the mix also influences the roughness of the material (38). More viscous glass ionomer cements tend to have higher porosities and in turn higher surface roughness values. Manufacturing of glass ionomer cements with smaller sized particles with uniform shape and structure can additionally overcome the effects of surface roughness (39). Based on previous studies, the surface roughness of glass ionomer cements could be counteracted by increasing the time for finishing and polishing. Hence each brand showed varied differences in surface roughness in accordance with previous studies conducted (40). Our in vitro study results do not fully reflect what happens with the restorative glass ionomer cement in the oral cavity. Several other factors can also interfere with the surface roughness and longevity of a restorative material in the oral environment which includes the brushing frequency, age of person, changes in oral microbiota, quality of salivary flow and composition, diet methods, parafunctional habits, changes in occlusion, location of the restoration. We cannot include or modify all these environmental and patient related factors in an in vitro study. It is expected that an increase in surface roughness results in faster colonization of the surfaces and faster maturation of dental biofilm, thereby increasing the risk of caries, although glass ionomer cements present anticariogenic action due to fluoride release (41). The limitation of this study is that there was a limited sample size and only 2 types of composites were used.

CONCLUSION:

From the results obtained we can conclude that gold label brand glass ionomer cement showed less surface roughness when compared to D tech brand glass ionomer cement after brushing simulation with herbal and fluoridated toothpaste. The surface roughness results obtained in the oral cavity may differ from the results of this in vitro study. This is because the mechanical properties of a restorative material, as well as its longevity, susceptibility to fracture and appearance of roughness, may be associated with a series of factors inherent to the product and to the patient.

CONFLICT OF INTEREST:

The authors have no conflict of interest.

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AUTHORS' CONTRIBUTIONS:

Obuli Ganesh Kishore S, Balaji Ganesh S, S Jayalakshmi designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Obuli Ganesh Kishore S, Balaji Ganesh S, managed the analyses of the study. Obuli Ganesh Kishore S managed the literature searches. All authors read and approved the final manuscript.

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NOTE:

- The study highlights the efficacy of " HERBAL " which is an ancient tradition, used in some parts of India. This ancient concept should be carefully evaluated in the light of modern medical science and can be utilized partially if found suitable.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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