Indonesian Dental Association

Journal of Indonesian Dental Association

http://jurnal.pdgi.or.id/index.php/jida
ISSN: 2621-6183 (Print); ISSN: 2621-6175 (Online)

Research Article

Effect of 4.77% and 4.7% Alcoholic Drinks on Surface Roughness of Resin-Modified Glass Ionomer Cement

Dewi Liliany Margaretta[1§], Zaldy Farhan Adis[2]

[1] *Department of Dental Material, Faculty of Dentistry, Trisakti University, Indonesia*
[2] *Undergraduate Student, Faculty of Dentistry, Trisakti University, Indonesia*

Received date: May 15, 2021. **Accepted date:** August 18, 2021. **Published date:** October 31, 2021.

KEYWORDS

acidic pH;
alcoholic drink;
hybrid restorative material;
resin-modified;
RMGIC;
surface roughness

ABSTRACT

Introduction: Resin-modified glass ionomer cement (RMGIC) is a hybrid restorative material that combines resin and glass ionomer cement (GIC). The addition of hydroxyethyl methacrylate (HEMA) to RMGIC improves its physical properties, such as resistance to surface roughening. Food and drink often produce factors that trigger surface roughening. Beverages with alcohol contents of 4.77% and 4.7%, which are widely consumed by Indonesians, have acidic pH values. Rough surfaces promote bacterial adhesion and plaque accumulation, inducing secondary caries. **Objective:** The aim of the present study was to determine the difference in the surface roughness of RMGIC after immersion in beverages with alcohol contents of 4.77% and 4.7%. **Methods:** Twenty-two samples (diameter = 10 mm; height = 2 mm) were divided into three groups: Group I comprised eight samples of RMGIC soaked in a beverage with an alcohol content of 4.77%; Group II comprised eight samples of RMGIC soaked in a beverage with an alcohol content of 4.7%; and Group III comprised six samples of RMGIC soaked in distilled water as a control. Groups I and II were immersed for 34 min twice per day. The RMGIC was immersed in an incubator at 37°C for 21 days. The samples were then tested using Surface Roughness Tester S-100. **Results:** Each group had a different mean roughness value. One-way analysis of variance (ANOVA) and Tukey's post hoc analysis test indicated a significance value of $p = 0.021$. Tukey's post hoc analysis test revealed a significant difference in surface roughness between the RMGIC samples soaked in the beverage with an alcohol content of 4.77% and those soaked in distilled water. **Conclusion:** The beverage with an alcohol content of 4.77% produced a higher surface roughness value than the beverage with an alcohol content of 4.7% or the control over 21 days.

§ Corresponding Author
E-mail address: dewi_liliany@yahoo.com.sg (Margaretta DL)

DOI: 10.32793/jida.v4i2.686

INTRODUCTION

Resin-modified glass ionomer cement (RMGIC) is a restorative material that is often used by dentists.[1] It is usually used for patients with a high risk of caries, and can also be used for class I, II, III, or V GV Black restorations, aesthetic fillings, and restorations in areas were teeth are eroded or there is tooth abfraction.[2]

RMGIC powder comprises calcium fluoroluminosilicate glass, a matrix resin consisting of bisphenol-A-glycidyl-methacrylate (Bis-GMA) and triethylene glycol dimethacrylate (TEGDMA), and additional photo-initiators and fillers. Liquid RMGIC also contains hydroxyethyl methacrylate (HEMA).[3,4] HEMA is hydrophilic. Therefore, it can absorb enormous quantities of water and can affect the elasticity, aesthetics, and surface roughness of a restorative material if that material is exposed to a stimulating agent such as alchohol.[5,6]

Surface roughness causes differences in the surface characteristics of a restoration. Chemical exposure causes unwanted irregularity on a surface.[7,8] Surface roughness is a predisposing factor that can lead to the emergence of biofilms and plaque build-up due to bacteria adhering to the restored surface. The development of micropores in the RMGIC also causes discoloration of the restoration material.[9]

Based on the World Health Organization (WHO) database of 2018, Indonesian adults often consume beer with ethanol concentrations of 4.77% and 4.7%.[10] The ethanol contents and low pH values of alcoholic beverages can trigger HEMA to absorb water, dissolving the resin and filler matrix in RMGIC. This ultimately creates extrinsic surface roughness.[11,12]

A previous study on the surface roughness of a composite resin restoration material immersed in an alcoholic beverage with a pH of 4.1 and an ethanol content of 5% revealed that the beverage produced high surface roughness in the material, which contained a resin matrix similar to that of RMGIC.[12,13] The present study was carried out to determine differences in surface roughness after the immersion of RMGIC in alcoholic beverages.

MATERIALS AND METHODS

This experimental research was designed as post test only with control group. All steps of the experiment were conducted at DMT-Core, The Faculty of Dentistry at Trisakti University between September and October 2020. The samples used in the present study comprised capsule RMGIC (EQUIA Forte®, GC, Japan, LOT No. 1812201), and were mixed in a glass ionomer cement (GIC) mixer for 10 seconds. The mixed RMGIC was then inserted into a mold with a diameter of 10 mm and a height of 2 mm using a GIC capsule gun applicator. Each sample was subsequently irradiated for 20 seconds using a nonporous light-curing unit with a flat surface (Fig.1).

The 22 samples prepared by the method described above were divided into 3 groups: Group I comprised 8 samples for immersion in a 4.77% alcohol beverage (Anker®; Delta Djakarta, Bekasi, Indonesia); Group II comprised 8 samples for immersion in a 4.7% alcohol beverage (Bintang®; Multi Bintang Indonesia, Surabaya, Indonesia); and Group III comprised 6 samples for immersion in distilled water (the control group).

Prior to immersion, each sample was immersed in distilled water at 37°C for 24 hours to adjust it to the physiological temperature of the oral cavity. The pH of each solution was determined. In the present study, each sample in the treatment groups was immersed in the 4.77% or 4.7% alcohol content beverages for 34 minutes twice per day. The control samples were immersed in distilled water, which was replaced every 24 hours. Each sample was immersed at 37°C for 21 days. After 21 days, each sample was tested for surface roughness. Surface roughness was measured using an optical profilometer (Taylor Hobson, Surtronic S-100 series: Amatek®, Philadelphia, USA) with a calibrated transverse length of 2.40 mm, an interval (cut-off length) of 0.80 mm, and a gauge range of 400 µm.

Statistical Analysis

In the present study, statistical analysis was performed using SPPS Microsoft version 20 (IBM, Armonk, NY). The data were analyzed using the Shapiro–Wilk normality test and Levene's homogeneity test, which verified that they were normally distributed and homogeneous. The results were then investigated using one-way analysis of variance (ANOVA) and Tukey's post hoc test to determine differences in the surface roughness in each group. Significance was set at $p < 0.05$.

Figure 1. Resin-modified glass ionomer cement (RMGIC) sample on the stainless-steel mold

RESULTS

The differences in surface roughness after immersion of the Group I and Group II samples are presented in Table 1. The surface roughness test values for Groups I, II, and III analyzed using the Shapiro–Wilk test and Levene's test had p-values of >0.05, which indicated that the data variants were normally distributed and homogeneous. Based on the results of the normality and homogeneity tests, analysis was continued with one-way ANOVA tests. The one-way ANOVA test results indicated a p-value = 0.021, which revealed a significant difference in RMGIC surface roughness between the treatment and control groups. A Tukey's post hoc test was performed to reveal significant differences among the obtained data (Table 2). The results of the Tukey's post hoc test shown in Table 2 indicate a p-value <0.05, which demonstrates a significant difference in RMGIC surface roughness between the samples in Group I and those in Group III.

Table 1. Average resin-modified glass ionomer cement (RMGIC) surface roughness values of each group

	Mean ± SD
Alcoholic drink (4.77%)	2.33 mm ± 0.182^{a,b}
Alcoholic drink (4.7%)	1.74 mm ± 0.365
Control	1.65 mm ± 0.734^{b}

^{a,b} The letters indicate significant differences on alcoholic drinks (4.77%) group and Control group as determined by one-way analysis of variance (ANOVA) and Tukey's post hoc tests.

Table 2. Tukey's post hoc test results

Sample	**p-value**
Alcoholic drink (4.77%) – Control	0.021*
Alcoholic drink (4.77%) – Alcoholic drink (4.7%)	0.835
Alcoholic drink (4.7%) – Control	0.062

*Significant difference (p <0.05)

DISCUSSION

Surface roughness is irregularity of the surface of a restoration material, and is due to exposure of the chemical composition of that material.[13] Bacterial accumulation is highly dependent on the surface characteristics and roughness of a restoration material, which can affect the retention of a biofilm.[14] RMGIC comprises particles of calcium fluoroaluminosilicate, which contain fluoride ions. Fluoride ions have anti-bacterial and anti-cariogenic properties. They also reduce demineralization and increase remineralization, and are therefore expected to reduce the attachment of accumulated bacteria.[15,16]

The surface roughness of a restoration material can be affected by extrinsic factors such as the acidity of compounds found in food or drink.[7,17] Two mechanisms are responsible for changes in surface roughness. In the first mechanism involves a decrease in metal cations in the matrix; the removal of ions from the surface the GIC glass particles alters the solubility of the matrix in the RMGIC restoration material. In the second mechanism, the release of metal cations causes an increase in free oxygen on the glass surface, which increases the number of silanol groups. The two mechanisms continuously affect the diffusion of hydrogen ions, fluoride ions, and metal cations, which dissolve the GIC silicate groups in the RMGIC.[15] This leads to the complete dissolution of the glass particles and the formation of numerous pores, which coarsen the RMGIC restoration material.[18,19]

The ethanol (usually referred to simply as alcohol) in alcoholic beverages causes surface roughening owing to its physical and chemical properties as a solvent. Therefore, it can dissolve the organic resin matrix in an RMGIC, namely Bis-GMA and TEGDMA. This degrades the organic matrix and coarsens the restoration material.[20] The hydrophilic properties of RMGIC—which are attributable to HEMA—are promoted by exposure to ethanol, which causes marked water absorption leading to dissolution and degradation.[19] The dissolution process is caused by the diffusion of ions through water. Therefore, the diffusion process can occur more rapidly and to a greater extent through the resin matrix of the RMGIC.[21] The process of degradation is due to water absorption by the resin matrix. This results from the hydrolysis of the filler bonds and the resin matrix, and has several effects. The effects include reduced molecular weight, the occurrence of gaps between the matrix bonds and the filler, and a deterioration of the physical and mechanical properties of the RMGIC, such as increased surface roughness.[9,17]

The results of the present study corroborate those from Permatasari's study on the surface roughness of RMGIC after immersion in acidic river water (pH=4.07)—i.e., increased roughness.[19] They also support the results obtained by Da Silva et al., which indicate that the ethanol content of alcoholic beverages can affect the surface roughness of the restoration material.[13]

The formation of numerous micropores on the RMGIC surface results from contact with an alcoholic beverage, which promotes interaction between the bioactive components in the beverage and the bonding of the polyacrylic acid matrix in the RMGIC particles. Furthermore, the presence of undetectable surface microporosity during sampling in each group results in greater than expected surface roughness at the time of measurement.[22]

CONCLUSION

The current research demonstrated that the beverage with an alcohol content of 4.77% caused greater surface roughness than the beverage with an alcohol content of 4.7% or the control. The influence of the frequency of consumption of alcoholic beverages and other variants of alcoholic drinks is an interesting topic for future investigation.

Acknowledgment

The author would like to thank the Faculty of Dentistry at Trisakti University for supporting this study.

Conflict of Interest

The authors declare that there are no conflicts of interest.

REFERENCES

1. Suprastiwi E. Analysis of fluoride released from GIC and RMGIC in saliva and dentino-enamel substance. MakaraKes. 2010;13(2):53-58.
2. Sakaguchi R, Ferrance J, Powers J. Craig's restorative dental materials. 14th ed. Amsterdam: Elsevier; 2018. pp. 156-166.
3. Kim YK, Kim K-H, Kwon T-Y. Setting reaction of dental resin-modified glass ionomer restoratives as a function of curing depth and post-irradiation time. J Spectrosc. 2015;(2015):1–8.
4. Kooi T, Tan Q, Yap A, Guo W, Tay K, Soh M. Effects of food-simulating liquids on surface properties of giomer restoratives. Oper Dent. 2012;37(6):665–671.
5. Berzins DW, Abey S, Costache M, Wilkie CA, Roberts H. Resin-modified glass-ionomer setting reaction competition. J Dent Res. 2010;89(1): 82–86.
6. Zhao J, Xie D. A novel hyperbranched poly (acrylic acid) for improved resin-modified glass-ionomer restoratives. J Dent Mater. 2011; 27(5):478–486.
7. Kurniawati AC, Tjandrawinata R. Pengaruh perendaman infused water dan penyikatan gigi terhadap kekasaran permukaan semen ionomer kaca modifikasi resin. J Mater Kedokt Gigi. 2014;3(2):67–74.
8. Lepri CP, Palma-Dibb RG. Surface roughness and color change of a composite: Influence of beverages and brushing. Dent Mater J. 2012;31(4):689–696.
9. Wardhani WP, Meizarini A, Yuliati A, Apsari R. Perubahan warna semen ionomer kaca setelah direndam dalam larutan teh hitam. J Dentomaxillofacial Sci. 2010;9(2):123.
10. World Health Organization. Management of substance abuse team. Global status report on alcohol and health 2018. Geneva: World Health Organization; 2018.
11. Magista M, Nuryanti A, Wahyudi I. Pengaruh lama perendaman dan jenis minuman beralkohol bir dan tuak terhadap kekerasan email gigi manusia (in vitro). Dent J Maj Kedok Gigi Indonesia. 2014;21(2):47-55.
12. Marghalani HY. Effect of filler particles on surface roughness of experimental composite series. J Appl Oral Sci. 2010; 18(1):59–67.
13. Da Silva MAB, Vitti RP, Sinhoreti MAC, Consani RLX, Silva-Júnior JG da, Tonholo J. Effect of alcoholic beverages on surface roughness and microhardness of dental composites. Dent Mater J. 2016;35(4):621–626.
14. Poggio C, Dagna A, Chiesa M, Colombo M, Scribante A. Surface roughness of flowable resin composites eroded by acidic and alcoholic drink. J Conserv Dent JCD. 2012;15(2):137.
15. Neelakantan P, John S, Anand S, Sureshbabu N, Subbarao C. Fluoride release from a new glass-ionomer cement. Oper Dent. 2011;36(1):80–85.
16. Tjandrawinata R, Julianto A. Efek perendaman air jeruk nipis dan air jeruk lemon pada kekasaran permukaan semen ionomer kaca. J Mater Kedokt Gigi. 2018;7(2):11-16.
17. Namineni S, Satish V, Prabhakar A, Devi C, Maganur P. Effect of soft drink and fresh fruit juice on surface roughness of commonly used restorative materials. Int J Clin Pediatr Dent. 2015;8(1):1–5.
18. Maharani N, Wibowo A, Aripin D, Fadil MR. Perbedaan nilai kekerasan permukaan glass ionomer cement (GIC) dan resin modified glass ionomer cement (RMGIC) akibat efek cairan lambung buatan secara in vitro. Padja J Dent Res Stud. 2017;1(2):77-83.
19. Permatasari AP, Nahzi MYI. Kekasaran permukaan resin-modified glass ionomer cement setelah perendaman dalam air sungai. Dent J Kedokt Gigi. 2016;1(2):164-168.
20. Roeroe VM, Wicaksono DA, Juliatri J. Gambaran kekuatan tekan bahan tumpatan semen ionomer kaca yang direndam dalam minuman beralkohol. J E-GIGI. 2015;3(1):1-6.

22. Hwang S, Chung S, Lee J-T, Kim Y-T, Kim Y, Oh S, et al. Influence of acid, ethanol, and anthocyanin pigment on the optical and mechanical properties of a nanohybrid dental composite resin materials. MDPI. 2018;11(7):1234-6.
23. Sande FH, Silva AF, Michelon D, Piva E, Cenci MS, Demarco FF. Surface roughness of orthodontic band cements with different compositions. J Appl Oral Sci. 2011;19(3):223–227.