Comparative evaluation of surface roughness of two commercially available glass ionomer cements after immersion in different fruit juices - An in vitro study

Amrithaashri S[1], Balaji Ganesh S*[2], S. Jayalakshmi[3]

[1]Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077, India

[2,3]Reader, White lab-Material Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600077, India

Corresponding Author: Dr. Balaji Ganesh S, Reader, White lab-Material Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600077, India

ABSTRACT:

INTRODUCTION: Glass ionomer cement (GIC) materials have been used in dentistry for multiple purposes. The surface roughness of a restorative material has a significant impact on its esthetic appearance, wear and lifespan. Acidic liquids, such as soft drinks can cause restorative materials to degrade. The aim of the study was to evaluate the surface roughness of two commercially available glass ionomer cements after immersion in different fruit juices. **MATERIALS AND METHODS**: Two glass ionomer cement brands called d-tech and shofu were taken. 8 samples were prepared and tested for surface roughness before and after immersion in lemon and grape juice. They were immersed in beakers containing juices at room temperature for a period of 7 days. Mitutoyo SJ-310 stylus profilometer was used in this study for surface roughness evaluation. **RESULTS:** No changes were seen in surface roughness Ra, Rq and Rz values before and after immersion in fruit juices. Independent T test was done, this difference is statistically not significant (p=0.166). **CONCLUSION**: Lemon and grape juice evaluated in this study did not alter the surface roughness of the tested restorative materials. It is concluded that there are no significant changes in the surface roughness of both D Tech ahd Shofu brand glass ionomer cement.

Keywords: Glass ionomer cement, Innovative measurement, Surface roughness, Fruit juices, Profilometer

INTRODUCTION:

Glass ionomer cement (GIC) materials have been used in dentistry for multiple purposes. They are used as restorative materials, especially in the primary dentition and also as liners and bases, as fissure sealants and as bonding agents for orthodontic brackets.(1) (2)There are several types of glass ionomer cement and new modified types are also produced; while selecting the restorative material it is vital to understand the physical and mechanical qualities of different brands and new products. (3)Resin modified glass ionomer cements and bonded nanofiller technology have the advantage of improving the polish and esthetic properties of glass ionomers. (4)Although there are few studies on the mechanical characteristics of ordinary GIC and resin-modified GIC, there is not

enough information on new nanoparticle GIC. The therapeutic success of restorations in the oral context is determined by their long-term life.(5)

The rough surface of dental restorations can cause increased friction and a high surface wear rate.(6) The surface roughness of a restorative material has a significant impact on its esthetic appearance, wear and lifespan.(7) Acidic liquids, such as soft drinks can cause restorative materials to degrade and they cause bacterial accumulation on the surfaces of restoration which will lead to the development of secondary caries and periodontal diseases.(8) High use of acidic beverages may be etiological and exacerbating factors in severe dental erosion.(9) Factors that produce surface alterations on enamel can also have an impact on the restoration's qualities. This affects the restoration's life, because the restorative material's final success is determined by how long it lasts in the oral cavity.(10)

Chemical composition of the restorative material and external factors such as the finishing/polishing of the restoration may influence the surface roughness. Furthermore, the effect of a beverage on materials may be exactly proportional to the volume and frequency with which it is consumed.(11) Clinical acceptance is higher for restorative materials that meet the above requirements. The materials of choice for reconstructing such cervical lesions are resin composites and glass ionomer cements.(12). The aim of the study was to evaluate the surface roughness of two commercially available glass ionomer cements after immersion in different fruit juices.

MATERIALS AND METHODS:

The in-vitro study was carried out in the white lab of Saveetha dental college, Chennai, India. Two glass ionomer cement brands called D-tech and Shofu were used for the study. They were analysed using 2 different types of citric acid juices (grape and lemon). Totally 8 samples were prepared using addition silicone moulds. Disks of specified size and shape were fabricated using two restorative GIC. These 8 samples were tested for surface roughness before and after exposure by using 2 juices which were grape and lemon juice. The mould was slightly overfilled with glass ionomer cement and the sample was removed. Then it was smoothened by using a polishing bur and micromotor. All the specimens were subjected to profilometry analysis for the recording of initial surface roughness before being subjected to the experimental immersion procedure. Mitutoyo SJ-310 Stylus profilometer was used in this study. Then the samples were further divided into subgroups of two samples each for each of the fruit juices and they were immersed in beakers containing juices at room temperature for a period of 7 days. Surface roughness was then again evaluated by a stylus profilometer using 2µm/60 degree angle and results were subjected to statistical analysis.Independent T test was conducted.

RESULTS:

The Ra, Rq and Rz value of the samples was obtained. In the present study, samples were subjected to lemon juice, grape juice and distilled water. The pre and post immersion Ra, Rq and Rz surface roughness mean values were 0.003, 0.004 and 0.05. (Table 1). The statistics was also analysed,

The difference between d tech and shofu was analysed. The results suggest that both d tech and shofu ra, rq, and rz values did not change after immersion in the fruit juices. No changes were seen in surface roughness values. Independent T test was done, This difference is statistically not significant p=0.166. (Figure 1)

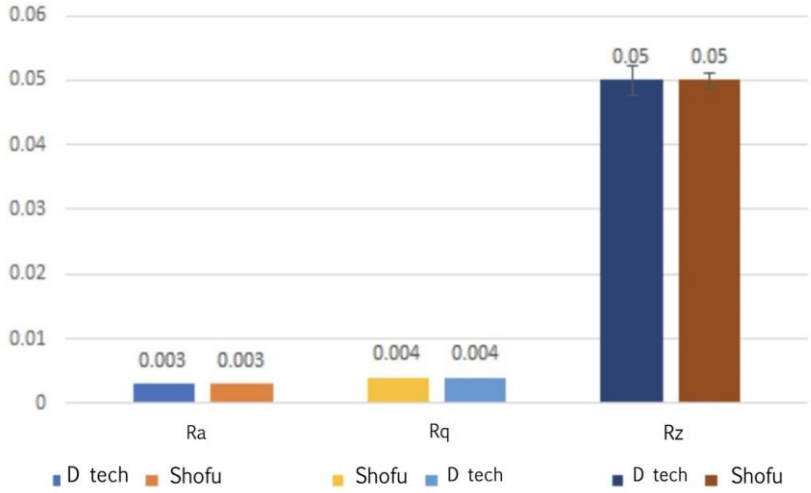

Figure 1: The bar graph depicts the association between types of GIC and the mean difference in the surface roughness Blue and orange denote the Ra mean difference value of d tech and shofu respectively, yellow and sky blue denotes the Rq mean difference value of d tech and shofu respectively, dark blue and brown denotes the Rz mean difference value of d tech and shofu respectively. No changes were seen in surface roughness values. Independent T test was done, This difference is statistically not significant p=0.166.

Table 1: Mean, std deviation and significance values between the groups

	Groups	**Mean**	**Std. Deviation**	**Significance**
Ra	D tech	0.003	1.679	0.166
	Shofu	0.003	1.679	
Rq	D tech	0.004	0.00	
	Shofu	0.004	0.00	
Rz	D tech	0.050	0.002	
	Shofu	0.050	0.001	

DISCUSSION:

Erosion of the tooth surface might occur as a result of food or drinks containing a range of acidic components.(13)The immersion regime used in the research was analogous to an individual's intake of drinks. To neutralize the pH of the drinks, the pellets were rinsed in regular saline before and after each immersion. (14)These cations eventually disperse outward to reach the surface. As the concentration of metal ions in the matrix falls, more ions around the glass particles are removed, resulting in more dissolution of the GIC. (15)As a result, the GIC's exterior surface becomes more void and rugged, with protruding undissolved glass fragments. As a result, prolonged exposure of the glass ionomer material to low pH liquids would result in altered surface roughness.(16)

The ongoing development of novel restorative materials has resulted from the hunt for an optimal restorative material to replace tooth tissue with adhesive and caries protective qualities, as well as a straightforward clinical application process. (17,18) Surface roughness and microleakage of eroded tooth-colored dental restorative material was evaluated in a study. All types of glass ionomer cements were eroded after exposure to the acidic drink.(19) Filtek Z250 and Ketac Molar Easymix showed more microleakage in the study groups.(20)In our study, there was no alteration in surface roughness value evident after exposure of D tech and shofu GIC to lemon and grape juice. (21)

The interaction of a conventional GIC, two resin-modified GIC and two compomers with acidic juices was investigated in a study. (22)They concluded that conventional GIC gets dissolved completely in apple and orange juice, but survives in Coca-Cola juice with a significantly reduced hardness after one year. Fruit juices pose a great erosive threat to tooth coloured restorative materials.(23) (24) The limitations of our study is small sample size and we immersed the GIC samples for only 7 days. In future, we can follow long term immersion protocols for a period of six months to a year and analyse the surface roughness properties of different types of GIC such as conventional, resin modified and nano particle added restorative materials.

CONCLUSION:

Lemon and grape juice evaluated in this study did not alter the surface roughness of the tested restorative materials. It is concluded that there are no significant changes in the surface roughness of both D Tech ahd Shofu brand glass ionomer cement.

ACKNOWLEDGEMENT:

The first author would like to thank the faculty members of the White lab, Saveetha Dental College and Hospital, Chennai for helping out with research.

CONFLICT OF INTEREST:

The authors declare that there was no conflict of interest.

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
- Cigram capitals, karur.

REFERENCES:

1. Yazkan B. Surface degradation evaluation of different self-adhesive restorative materials after prolonged energy drinks exposure. J Esthet Restor Dent. 2020 Oct;32(7):707–14.
2. Jose SM, Balaji Ganesh S, Jayalakshmi S. Effect of Brushing Simulation on the Surface Roughness of Two Different Commercially Available Glass Ionomer Cements - An In Vitro Study. J Pharm Res Int. 2022 Jan 28;25–32.
3. Keerthana B, Balaji Ganesh S, Jayalakshmi S. Evaluation of flexural strength of glass ionomer cement after immersion in fruit juices. Journal of Advanced Pharmaceutical Technology & Research. 2022 Nov 30;13(Suppl 1):S156.
4. Hussainy SN, Nasim I, Thomas T, Ranjan M. Clinical performance of resin-modified glass ionomer cement, flowable composite, and polyacid-modified resin composite in noncarious cervical lesions: One-year follow-up. Journal of conservative dentistry : JCD [Internet]. 2018 Sep [cited 2025 Feb 19];21(5). Available from: https://pubmed.ncbi.nlm.nih.gov/30294112/
5. Savas S, Colgecen O, Yasa B, Kucukyilmaz E, Others. Color stability, roughness, and water sorption/solubility of glass ionomer--Based restorative materials. Niger J Clin Pract. 2019;22(6):824.
6. Hussein TA, Bakar WZW, Ghani ZA, Mohamad D. The assessment of surface roughness and microleakage of eroded tooth-colored dental restorative materials. J Conserv Dent. 2014 Nov;17(6):531–5.
7. Imtiaz T, Ganesh SB, Jayalakshmi S. Surface roughness changes of two composite resin restorative materials after thermocycling. J Adv Pharm Technol Res. 2022 Dec;13(Suppl 2):S466–9.
8. Hengtrakool C, Kukiattrakoon B, Kedjarune-Leggat U. Effect of naturally acidic agents on microhardness and surface micromorphology of restorative materials. Eur J Dent. 2011 Jan;5(1):89–100.
9. Guedes APA, Oliveira-Reis B, Catelan A, Suzuki TYU, Briso ALF, Santos PHD. Mechanical and surface properties analysis of restorative materials submitted to erosive challenges in situ. Eur J Dent. 2018 Oct;12(4):559–65.
10. Mohamed Arsath N, Balaji Ganesh S, Jayalakshmi S. Comparative Evaluation of Surface Roughness of Cention N after Brushing Simulation with Herbal and Fluoridated Toothpaste - An In-vitro Study. J Pharm Res Int. 2021 Dec 26;2680–7.
11. Valinoti AC, Neves BG, da Silva EM, Maia LC. Surface degradation of composite resins by acidic medicines and pH-cycling. J Appl Oral Sci. 2008 Jul;16(4):257–65.
12. Mullan F, Austin RS, Parkinson CR, Hasan A, Bartlett DW. Measurement of surface roughness changes of unpolished and polished enamel following erosion. PLoS One. 2017

Aug 3;12(8):e0182406.

13. Mount GJ, Hume WR, Ngo HC, Wolff MS. Preservation and Restoration of Tooth Structure. John Wiley & Sons; 2016. 328 p.
14. Sawant K, Pawar AM, Banga KS, Machado R, Karobari MI, Marya A, et al. Dentinal Microcracks after Root Canal Instrumentation Using Instruments Manufactured with Different NiTi Alloys and the SAF System: A Systematic Review. NATO Adv Sci Inst Ser E Appl Sci. 2021 May 28;11(11):4984.
15. Eren MM. Effects of Acidic/Alcoholic Beverages on the Surface Roughness of Composite Resins Light-Cured for Two Different Periods of Time. STOMATOLOGY EDU JOURNAL [Internet]. 2021 Oct 26 [cited 2025 Feb 19]; Available from: https://www.academia.edu/60025571/Effects_of_Acidic_Alcoholic_Beverages_on_the_Surface_Roughness_of_Composite_Resins_Light_Cured_for_Two_Different_Periods_of_Time
16. Kamala KR, Annapurni H, Others. Evaluation of surface roughness of glazed and polished ceramic surface on exposure to fluoride gel, bleaching agent and aerated drink: An in vitro study. J Indian Prosthodont Soc. 2006;6(3):128.
17. Poggio C, Dagna A, Chiesa M, Colombo M, Scribante A. Surface roughness of flowable resin composites eroded by acidic and alcoholic drinks. Journal of Conservative Dentistry. 2012 Jan 1;15(2):137.
18. View of Nano Glass Ionomer Cement- A Review [Internet]. [cited 2025 Feb 19]. Available from: https://jchr.org/index.php/JCHR/article/view/2335/1701
19. Detogni A. Impact of dietary acids on the surface roughness and morphology of composite resins. Journal of Oral Science [Internet]. 2021 Sep 29 [cited 2025 Feb 19]; Available from: https://www.academia.edu/53948305/Impact_of_dietary_acids_on_the_surface_roughness_and_morphology_of_composite_resins
20. Pujari S. Effects of Commonly Consumed Beverages on Surface Roughness and Color Stability of the Nano, Microhybrid and Hybrid Composite Resins: An in vitro Study. The Journal of Contemporary Dental Practice [Internet]. 2013 Jan 1 [cited 2025 Feb 19]; Available from: https://www.academia.edu/83223725/Effects_of_Commonly_Consumed_Beverages_on_Surface_Roughness_and_Color_Stability_of_the_Nano_Microhybrid_and_Hybrid_Composite_Resins_An_in_vitro_Study
21. Mujdeci A. The Effect of Mouthrinses on Surface Roughness of Two Nanohybrid Resin Composites. Brazilian Dental Science [Internet]. 2021 Jan 1 [cited 2025 Feb 19]; Available from: https://www.academia.edu/104621632/The_Effect_of_Mouthrinses_on_Surface_Roughness_of_Two_Nanohybrid_Resin_Composites
22. Mount GJ. An Atlas of Glass-Ionomer Cements: A Clinician's Guide. Thieme; 2002. 222 p.
23. Aliping-McKenzie M, Linden RWA, Nicholson JW. The effect of Coca-Cola and fruit juices

on the surface hardness of glass-ionomers and "compomers." J Oral Rehabil. 2004 Nov;31(11):1046–52.

24. Sivarajan M, Rakshagan V, Govindaraju L. Choice of Restorative Material by Dentists for Class I Caries in Second Mandibular Primary Molar in 3-6 Year Children Visiting a University Dental Hospital "A Retrospective Study. J Adv Med Med Res. 2024 Feb 1;36(1):105–14.