Original Article

Effect of carbonated beverages on flexural strength property of restorative glass ionomer cement

S. Ganesh, S. Balaji Ganesh[1], S. Jayalakshmi[1]

Undergraduate Student, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, [1]White Lab - Material Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India

J. Adv. Pharm. Technol. Res.

Abstract

Glass ionomer cement (GIC) releases fluorides and has good biocompatibility, carbonated drinks, sometimes known as fizzy drinks, are carbonated liquids that contain dissolved carbon dioxide, sweeteners, and natural or artificial flavoring. The aim of our study is to determine the flexural strength of GIC after immersing in carbonated beverages. Twelve samples of GIC filling material were used among which six samples prepared were from the Dtech brand and six were prepared from the Shofu brand for the *in vitro* study. Bar-shaped specimens were prepared from each group with the dimension of 2 mm × 2 mm × 25 mm. They were immersed in Sprite, fizz drinks, and in distilled water as a control group. The immersion period was 7 days. Then, the determination of maximum force and displacement was done using INSTRON E3000 (ElectroPuls) universal testing machine, then the collected data were used to determine flexural strength. The mean flexural strength of Dtech GIC was 24.84 ± 6.523 Mpa. The mean flexural strength of Dtech GIC was 18.57 ± 11.60 Mpa. The independent sample *t*-test showed that $P = 0.247$ (>0.05) which was statistically not significant. The flexural strength of GIC material decreased after being immersed in Sprite and fizz drinks.

Key words: Fizzy drinks, flexural property, glass ionomer cement, innovative measurement

INTRODUCTION

The glass powder and polyacid are the components of glass ionomer cement (GIC), a water-based dental restorative material, which are set through an acid–base reaction. The creation of ionic connections between carboxylate groups and calcium makes it the only direct restorative substance that can chemically attach to hard tooth tissues.[1] They are used to treat early carious or erosion lesions.[2] GIC is currently categorized into nine categories based on application.[3] It releases fluorides and has good biocompatibility which has made it popular for restorations.[4]

When a lot of pressure or stress is applied to the restoration material, it is necessary to have a lot of flexural strength. The indications for which a material can be used are also determined by its flexural strength. Carbonated drinks or fizzy drinks are beverages containing dissolved carbon dioxide, sweeteners, and natural or artificial flavoring.[5] Acidic drinks are particularly damaging to primary teeth.[6] Furthermore, the amount and frequency with which a beverage is consumed may have a direct impact on the materials.[7]

Address for correspondence:
Dr. S. Balaji Ganesh,
White Lab - Material Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai - 600 077, Tamil Nadu, India.
E-mail: balajiganeshs.sdc@saveetha.com

Submitted: 27-Apr-2022 **Accepted:** 17-Jul-2022
Published: 30-Nov-2022

Access this article online
Quick Response Code:
Website: www.japtr.org
DOI: 10.4103/japtr.japtr_265_22

How to cite this article: Ganesh S, Ganesh SB, Jayalakshmi S. Effect of carbonated beverages on flexural strength property of restorative glass ionomer cement. J Adv Pharm Technol Res 2022;13:S186-9.

Flexural strength is a material's mechanical quality that can be described as the material's capacity to withstand deformation under load. The stress will be maximum at its edge (concave surface) whereas the stress will be minimum at the convex surface. For stress-bearing restorations such as posterior crowns, flexural strength is critical.[8] Flexural strength dictates which material should be used when high pressure/stress is applied to the restoration. The thickness of the restoration walls is also aided by flexural strength.[9] Our research and knowledge have resulted in high-quality publications from our team.[10-24] The aim of our study is to determine the flexural strength of GIC after immersing in carbonated beverages.

MATERIALS AND METHODS

Twelve samples of GIC filling material were used among which six samples prepared were from the Dtech brand and six were prepared from the Shofu brand for the *in vitro* study. Bar-shaped specimens were prepared from each group with the dimension of 2 mm × 2 mm × 25 mm with the using a mold of the prescribed dimension and every increment was cured for 30/s and polished using a micromotor with the polishing kit and final dimensions were checked using a digital caliper. Two GIC Dtech samples were immersed in fizz and Sprite. Two GIC Shofu samples were immersed in fizz and Sprite. Two GIC Shofu and two GIC Dtech samples were immersed in distilled water as a control group. The immersion period was 7 days. The samples were subjected to INSTRON E3000 (ElectroPuls) universal testing machine to determine the maximum force and maximum flexural displacement by a three-point bend test with a span length of 16 mm and a crosshead of 1 mm/min [Figure 1]. The data collected were used to determine the flexural strength.

The differences between the groups were determined by paired *t*-test analysis which was analyzed in IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Figure 1: The image depicts the determination of maximum force with INSTRON E3000 (Electroplus) universal testing machine

RESULTS

The mean flexural strength of Dtech GIC was 24.84 ± 6.523 Mpa. The mean flexural strength of Dtech GIC was 18.57 ± 11.60 Mpa. The mean flexural strength of Shofu GIC was decreased after immersion in Sprite and fizz. Compared to fizz immersed Dtech GIC, Sprite immersed GIC has high flexural strength. Flexural strength of GIC material decreased after being immersed in Sprite and fizz drinks. The independent sample *t*-test showed that $P = 0.247$ (>0.05) which was statistically insignificant [Table 1 and Figure 2].

DISCUSSION

Many studies have been done in the literature that deals with the flexural strength of dental restorative materials. Mitra studied the flexural strength of glass ionomer material that was stored for 1 day in saliva.[25] Xie studied the flexural strength of various commonly used GIC.[26] Artificial saliva and Vaseline, which are used as storage mediums, had no discernible effects on the GIC's flexural strength at any point of time.[27]

According to Cattani-Lorente *et al*., the physical properties of GIC immersed in water are reduced due to water molecules being absorbed by the cement.[28] In addition, matrix-forming ions are released into the medium to aid in

Table 1: Significance testing among the groups

Group	Mean	SD	Significance
Dtech GIC	24.8475	6.52348	0.247
Shofu GIC	18.5775	11.60752	

SD: Standard deviation, GIC: Glass ionomer cement

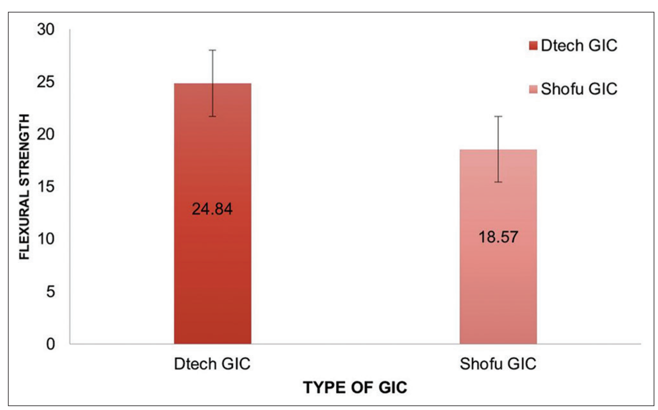

Figure 2: Bar graph representing the flexural strength of GIC samples immersed in sprite, fizz drinks. X axis depicts the different types of GIC and Y axis depicts mean flexural strength (M Pa). Red depicts the Dtech GIC whereas Light red depicts the Shofu GIC. Flexural strength of glass ionomer cement material decreased after being immersed in sprite and fizz drinks. GIC: Glass ionomer cement

the buffering process, modifying the material's strength.[29] Singer *et al*. study on the flexural strength of GIC modified by phytomedicines, plant extracts had no effect on the GIC's water sorption and solubility, but the flexural strength was increased by adding the plant extract at greater concentrations.[30] The chemical reaction that takes place during the setting, leads in hydration of the glass ionomer material and the production of larger density cross-links.[31]

Thongbai-On and Banomyong found that coating with a resin compound enhanced the flexural strength of either high powder liquid or resin-modified glass ionomer material in the dry state. Resin-modified GIC flexural strength was substantially higher than high powder liquid GIC, whether coated or bare. High powder liquid type has substantially larger porosities than resin-modified type. The porosities of noncoated and coated GIC material, on the other hand, were not significantly different.[32] Future scope is stated that the determination of flexural strength will help the dentist to choose more strengthened material to provide patients with better treatment and increase the prognosis of the treatment. Different brands have to be compared in an upcoming study.

CONCLUSION

The current investigation found that after being immersed in Sprite and fizz drinks, the flexural strength of GIC material reduced. Carbonated beverages have the potential to shorten the lifespan of restorations by altering the material's physical qualities.

Acknowledgment
The first author sincerely shows gratitude to the guides who provided insight and expertise that greatly assisted the research.

Financial support and sponsorship
The funds were provided by:
- Saveetha Dental College and Hospitals, Saveetha University of Medical and Technical Sciences, Saveetha University, Chennai
- Royal Hospital, Thanjavur.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Sidhu SK, Nicholson JW. A review of glass-ionomer cements for clinical dentistry. J Funct Biomater 2016;7:E16.
2. Garain R, Abidi M, Mehkri Z. Compressive and flexural strengths of high-strength glass ionomer cements: A systematic review. Int J Experiment Dent Sci 2020;9:25-9.
3. Tyas MJ, Burrow MF. Adhesive restorative materials: A review. Aust Dent J 2004;49:112-21.
4. Hafshejani TM, Zamanian A, Venugopal JR, Rezvani Z, Sefat F, Saeb MR, *et al*. Antibacterial glass-ionomer cement restorative materials: A critical review on the current status of extended release formulations. J Control Release 2017;262:317-28.
5. Shankar P, Venkatesan R, Senthil D, Trophimus J, Arthilakshmi CU, Princy P. Microleakage patterns of glass ionomer cement at cement-band and cement-enamel interfaces in primary teeth. Indian J Dent Res 2020;31:291-6.
6. Maganur P, Satish V, Prabhakar AR, Namineni S. Effect of soft drinks and fresh fruit juice on surface roughness of commonly used restorative materials. Int J Clin Pediatr Dent 2015;8:1-5.
7. Namineni S, Maganur PC, Prabhakar AR, Satish V, Kurthukoti A. Erosive effect of soft drink and fresh fruit juice on restorative materials. World J Dent 2013;4:32-40.
8. Mirchandani B, Padunglappisit C, Toneluck A, Naruphontjirakul P, Panpisut P. Effects of Sr/F-bioactive glass nanoparticles and calcium phosphate on monomer conversion, biaxial flexural strength, surface microhardness, mass/volume changes, and color stability of dual-cured dental composites for core build-up materials. Nanomaterials (Basel) 2022;12:1897.
9. Jaidka S, Somani R, Singh DJ, Shafat S. Comparative evaluation of compressive strength, diametral tensile strength and shear bond strength of GIC type IX, chlorhexidine-incorporated GIC and triclosan-incorporated GIC: An *in vitro* study. J Int Soc Prev Community Dent 2016;6:S64-9.
10. Vishnu Prasad S, Kumar M, Ramakrishnan M, Ravikumar D. Report on oral health status and treatment needs of 5-15 years old children with sensory deficits in Chennai, India. Spec Care Dentist 2018;38:58-9.
11. Eapen BV, Baig MF, Avinash S. An assessment of the incidence of prolonged postoperative bleeding after dental extraction among patients on uninterrupted low dose aspirin therapy and to evaluate the need to stop such medication prior to dental extractions. J Maxillofac Oral Surg 2017;16:48-52.
12. Krishnamurthy A, Sherlin HJ, Ramalingam K, Natesan A, Premkumar P, Ramani P, *et al.* Glandular odontogenic cyst: Report of two cases and review of literature. Head Neck Pathol 2009;3:153-8.
13. Dua K, Wadhwa R, Singhvi G, Rapalli V, Shukla SD, Shastri MD, *et al.* The potential of siRNA based drug delivery in respiratory disorders: Recent advances and progress. Drug Dev Res 2019;80:714-30.
14. Abdul Wahab PU, Senthil Nathan P, Madhulaxmi M, Muthusekhar MR, Loong SC, Abhinav RP. Risk factors for post-operative infection following single piece osteotomy. J Maxillofac Oral Surg 2017;16:328-32.
15. Thanikodi S, Kumar SD, Devarajan C, Venkatraman V, Rathinavelu V. Teaching learning optimization and neural network for the effective prediction of heat transfer rates in tube heat exchangers. Therm Sci 2020;24:575-81.
16. Subramaniam N, Muthukrishnan A. Oral mucositis and microbial colonization in oral cancer patients undergoing radiotherapy and chemotherapy: A prospective analysis in a tertiary care dental hospital. J Investig Clin Dent 2019;10:e12454.
17. Kumar SP, Girija AS, Priyadharsini JV. Targeting NM23-H1-mediated inhibition of tumour metastasis in viral hepatitis with bioactive compounds from Ganoderma lucidum: A computational study. Indian J Pharm Sci 2020;82:300-5.
18. Manickam A, Devarasan E, Manogaran G, Priyan MK, Varatharajan R, Hsu CH, *et al.* Score level based latent fingerprint enhancement and matching using SIFT feature. Multimed Tools Appl 2019;78:3065-85.
19. Ravindiran M, Praveenkumar C. Status review and the future prospects of CZTS based solar cell – A novel approach on the device structure and material modeling for CZTS based photovoltaic

device. Renew Sustain Energy Rev 2018;94:317-29.

20. Vadivel JK, Govindarajan M, Somasundaram E, Muthukrishnan A. Mast cell expression in oral lichen planus: A systematic review. J Investig Clin Dent 2019;10:e12457.
21. Ma Y, Karunakaran T, Veeraraghavan VP, Mohan SK, Li S. Sesame inhibits cell proliferation and induces apoptosis through inhibition of STAT-3 translocation in thyroid cancer cell lines (FTC-133). Biotechnol Bioprocess Eng 2019;24:646-52.
22. Mathivadani V, Smiline AS, Priyadharsini JV. Targeting Epstein-Barr virus nuclear antigen 1 (EBNA-1) with Murraya koengii bio-compounds: An *in-silico* approach. Acta Virol 2020;64:93-9.
23. Happy A, Soumya M, Venkat Kumar S, Rajeshkumar S, Sheba RD, Lakshmi T, *et al.* Phyto-assisted synthesis of zinc oxide nanoparticles using *Cassia alata* and its antibacterial activity against *Escherichia coli*. Biochem Biophys Rep 2019;17:208-11.
24. Prathibha KM, Johnson P, Ganesh M, Subhashini AS. Evaluation of salivary profile among adult type 2 diabetes mellitus patients in South India. J Clin Diagn Res 2013;7:1592-5.
25. Mitra SB, Kedrowski BL. Long-term mechanical properties of glass ionomers. Dent Mater 1994;10:78-82.
26. Xie D, Brantley WA, Culbertson BM, Wang G. Mechanical properties and microstructures of glass-ionomer cements. Dent Mater 2000;16:129-38.
27. Faridi MA, Khabeer A, Haroon S. Flexural strength of glass carbomer cement and conventional glass ionomer cement stored in different storage media over time. Med Princ Pract 2018;27:372-7.
28. Cattani-Lorente MA, Godin C, Meyer JM. Mechanical behavior of glass ionomer cements affected by long-term storage in water. Dent Mater 1994;10:37-44.
29. McKenzie MA, Linden RW, Nicholson JW. The physical properties of conventional and resin-modified glass-ionomer dental cements stored in saliva, proprietary acidic beverages, saline and water. Biomaterials 2003;24:4063-9.
30. Singer L, Bierbaum G, Kehl K, Bourauel C. Evaluation of the flexural strength, water sorption, and solubility of a glass ionomer dental cement modified using phytomedicine. Materials (Basel) 2020;13:E5352.
31. Azillah MA, Anstice HM, Pearson GJ. Long-term flexural strength of three direct aesthetic restorative materials. J Dent 1998;26:177-82.
32. Thongbai-On N, Banomyong D. Flexural strengths and porosities of coated or uncoated, high powder-liquid and resin-modified glass ionomer cements. J Dent Sci 2020;15:433-6.