Original Research Article

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

UNDER PEER REVIEW

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.

UNDER PEER REVIEW

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. 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 a - 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 standard and herbal toothpastes. (Figure 2) 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

UNDER PEER REVIEW

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.

UNDER PEER REVIEW

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

UNDER PEER REVIEW

RESULTS AND DISCUSSION:

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 were 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). It is expected that an increase in surface roughness results in faster colonization of the surfaces and faster maturation of dental plaque, 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.

UNDER PEER REVIEW

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. '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. 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. 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. 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. 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 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

UNDER PEER REVIEW

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	

UNDER PEER REVIEW

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	

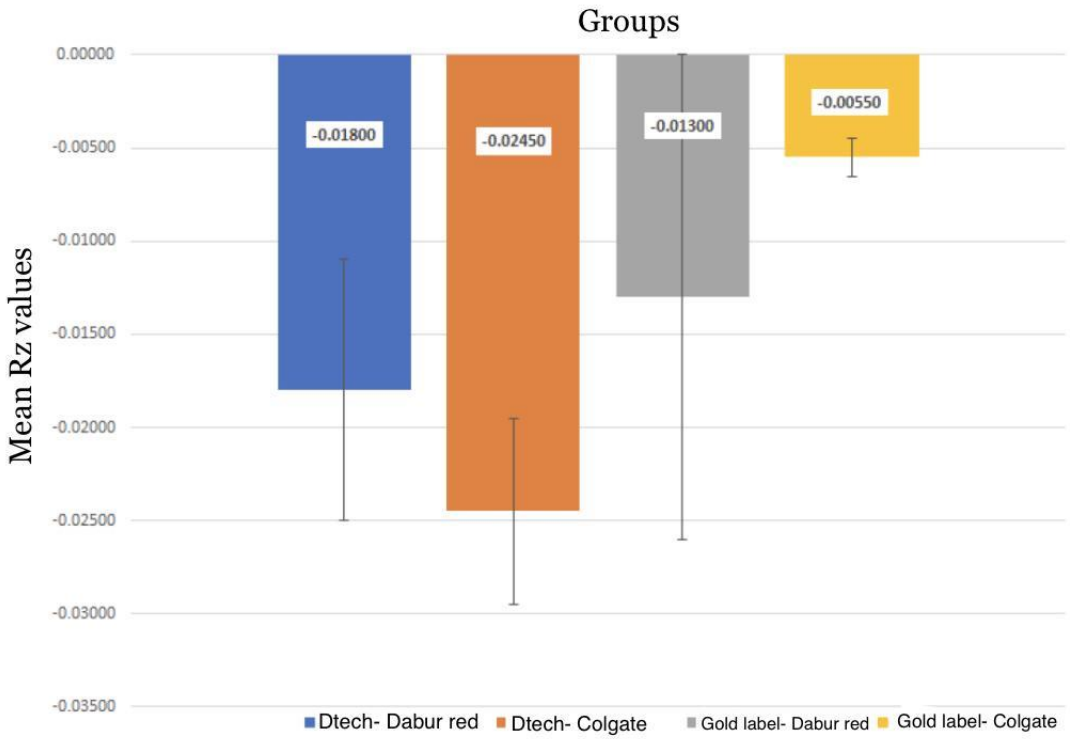

Figure.3: The bar graph shows Rz surface roughness values of D-Tech and Gold label brand of GIC pre and post brushing simulation with Dabur red toothpaste and Colgate toothpaste. Blue colour represents the mean Rz value of Dtech brand with dabur red, orange colour represents Dtech brand with Colgate, 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.

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.

CONFLICT OF INTEREST:

The authors have no conflict of interest.

ACKNOWLEDGEMENTS:

We thank Saveetha Dental college and Hospitals for providing us the support to conduct the study.

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.

SOURCE OF FUNDING:

The present study is funded by the following

- Saveetha Dental College and Hospitals , Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai
- Sarkav Health Services

- **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

UNDER PEER REVIEW

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.

REFERENCES:

1. Zanata R. Glass Ionomer Cements [Internet]. Textbook of Operative Dentistry. 2015. p. 420–420. Available from: http://dx.doi.org/10.5005/jp/books/12530_25

2. Pedley RD, Denison Pedley R. THE CAUSES AND INCIDENCE OF DENTAL CARIES [Internet]. Vol. 193, The Lancet. 1919. p. 80. Available from: http://dx.doi.org/10.1016/s0140-6736(01)25196-4

3. Sidhu S, Nicholson J. A Review of Glass-Ionomer Cements for Clinical Dentistry [Internet]. Vol. 7, Journal of Functional Biomaterials. 2016. p. 16. Available from: http://dx.doi.org/10.3390/jfb7030016

4. Webman M, Mulki E, Roldan R, Arevalo O, Roberts JF, Garcia-Godoy F. A Retrospective Study of the 3-Year Survival Rate of Resin-Modified Glass-Ionomer Cement Class II Restorations in Primary Molars. J Clin Pediatr Dent. 2016 Winter;40(1):8–13.

5. Souder W, Schoonover IC. Abrasion and Solution of Teeth [Internet]. Vol. 30, The Journal of the American Dental Association. 1943. p. 1725–34. Available from: http://dx.doi.org/10.14219/jada.archive.1943.0342

6. Institute NC, National Cancer Institute. Toothpaste [Internet]. Definitions. 2020. Available from: http://dx.doi.org/10.32388/46uiad

7. McKay A. Organic toothpaste [Internet]. Vol. 212, British Dental Journal. 2012. p. 206–206. Available from: http://dx.doi.org/10.1038/sj.bdj.2012.180

8. Sahu B, Mohanty R. Herbal Toothpaste: A Comprehensive Overview [Internet]. Vol. 10, Indian Journal of Public Health Research & Development. 2019. p. 1283. Available from: http://dx.doi.org/10.5958/0976-5506.2019.03700.8

UNDER PEER REVIEW

9. Rahardjo A, Gracia E, Riska G, Adiatman M, Maharani DA. Potential Side Effects of Whitening Toothpaste on Enamel Roughness and Micro Hardness [Internet]. Vol. 11, International Journal of Clinical Preventive Dentistry. 2015. p. 239–42. Available from: http://dx.doi.org/10.15236/ijcpd.2015.11.4.239

10. He J, Deng Y, Zhu F, Zhong T, Luo N, Lei L, et al. The Efficacy and Safety of a Herbal Toothpaste in Reducing Gingivitis: A Double-Blind, Randomized, Placebo-Controlled, Parallel Allocation Clinical Trial. Evid Based Complement Alternat Med. 2019 Feb 3;2019:3764936.

11. Lewis R, Dwyer-Joyce RS. Interactions between toothbrush and toothpaste particles during simulated abrasive cleaning [Internet]. Vol. 220, Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology. 2006. p. 755–65. Available from: http://dx.doi.org/10.1243/13506501jet96

12. Vajrabhaya L-O, Korsuwannawong S, Teinchai C, Salee W. Comparison of Enamel Surface Roughness after Brushing with Herbal and Non-herbal Toothpastes [Internet]. Vol. 11, World Journal of Dentistry. 2020. p. 215–20. Available from: http://dx.doi.org/10.5005/jp-journals-10015-1732

13. Muthukrishnan L. Imminent antimicrobial bioink deploying cellulose, alginate, EPS and synthetic polymers for 3D bioprinting of tissue constructs. Carbohydr Polym. 2021 May 15;260:117774.

14. PradeepKumar AR, Shemesh H, Nivedhitha MS, Hashir MMJ, Arockiam S, Uma Maheswari TN, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis. J Endod. 2021 Aug;47(8):1198–214.

15. Chakraborty T, Jamal RF, Battineni G, Teja KV, Marto CM, Spagnuolo G. A Review of Prolonged Post-COVID-19 Symptoms and Their Implications on Dental Management. Int J Environ Res Public Health [Internet]. 2021 May 12;18(10). Available from: http://dx.doi.org/10.3390/ijerph18105131

UNDER PEER REVIEW

16. Muthukrishnan L. Nanotechnology for cleaner leather production: a review. Environ Chem Lett. 2021 Jun 1;19(3):2527–49.

17. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? J Dent Sci. 2020 Dec;15(4):562–3.

18. Narendran K, Jayalakshmi, Ms N, Sarvanan A, Ganesan S A, Sukumar E. Synthesis, characterization, free radical scavenging and cytotoxic activities of phenylvilangin, a substituted dimer of embelin. ijps [Internet]. 2020;82(5). Available from: https://www.ijpsonline.com/articles/synthesis-characterization-free-radical-scavenging-and-cytotoxic-activities-of-phenylvilangin-a-substituted-dimer-of-embelin-4041.html

19. Reddy P, Krithikadatta J, Srinivasan V, Raghu S, Velumurugan N. Dental Caries Profile and Associated Risk Factors Among Adolescent School Children in an Urban South-Indian City. Oral Health Prev Dent. 2020 Apr 1;18(1):379–86.

20. 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.

21. Bhavikatti SK, Karobari MI, Zainuddin SLA, Marya A, Nadaf SJ, Sawant VJ, et al. Investigating the Antioxidant and Cytocompatibility of Mimusops elengi Linn Extract over Human Gingival Fibroblast Cells. Int J Environ Res Public Health [Internet]. 2021 Jul 4;18(13). Available from: http://dx.doi.org/10.3390/ijerph18137162

22. Karobari MI, Basheer SN, Sayed FR, Shaikh S, Agwan MAS, Marya A, et al. An In Vitro Stereomicroscopic Evaluation of Bioactivity between Neo MTA Plus, Pro Root MTA, BIODENTINE & Glass Ionomer Cement Using Dye Penetration Method. Materials [Internet]. 2021 Jun 8;14(12). Available from: http://dx.doi.org/10.3390/ma14123159

23. Rohit Singh T, Ezhilarasan D. Ethanolic Extract of Lagerstroemia Speciosa (L.) Pers., Induces Apoptosis and Cell Cycle Arrest in HepG2 Cells. Nutr Cancer. 2020;72(1):146–56.

24. Ezhilarasan D. MicroRNA interplay between hepatic stellate cell quiescence and activation.

UNDER PEER REVIEW

Eur J Pharmacol. 2020 Oct 15;885:173507.

25. Romera A, Peredpaya S, Shparyk Y, Bondarenko I, Mendonça Bariani G, Abdalla KC, et al. Bevacizumab biosimilar BEVZ92 versus reference bevacizumab in combination with FOLFOX or FOLFIRI as first-line treatment for metastatic colorectal cancer: a multicentre, open-label, randomised controlled trial. Lancet Gastroenterol Hepatol. 2018 Dec;3(12):845–55.

26. Raj R K, D E, S R. β-Sitosterol-assisted silver nanoparticles activates Nrf2 and triggers mitochondrial apoptosis via oxidative stress in human hepatocellular cancer cell line. J Biomed Mater Res A. 2020 Sep;108(9):1899–908.

27. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. J Periodontol. 2019 Dec;90(12):1441–8.

28. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species [Internet]. Vol. 94, Archives of Oral Biology. 2018. p. 93–8. Available from: http://dx.doi.org/10.1016/j.archoralbio.2018.07.001

29. Uma Maheswari TN, Nivedhitha MS, Ramani P. Expression profile of salivary micro RNA-21 and 31 in oral potentially malignant disorders. Braz Oral Res. 2020 Feb 10;34:e002.

30. Gudipaneni RK, Alam MK, Patil SR, Karobari MI. Measurement of the Maximum Occlusal Bite Force and its Relation to the Caries Spectrum of First Permanent Molars in Early Permanent Dentition. J Clin Pediatr Dent. 2020 Dec 1;44(6):423–8.

31. Chaturvedula BB, Muthukrishnan A, Bhuvaraghan A, Sandler J, Thiruvenkatachari B. Dens invaginatus: a review and orthodontic implications. Br Dent J. 2021 Mar;230(6):345–50.

32. Kanniah P, Radhamani J, Chelliah P, Muthusamy N, Joshua Jebasingh Sathiya Balasingh E, Reeta Thangapandi J, et al. Green synthesis of multifaceted silver nanoparticles using the flower extract of Aerva lanata and evaluation of its biological and environmental applications. ChemistrySelect. 2020 Feb 21;5(7):2322–31.

UNDER PEER REVIEW

33. Combe E. A protocol for determining the surface free energy of dental materials [Internet]. Vol. 20, Dental Materials. 2004. p. 262–8. Available from: http://dx.doi.org/10.1016/s0109-5641(03)00102-7

34. International Organization for Standardization. Measurement of Surface Roughness Parameters. 1984. 5 p.

35. Gharechahi M, Moosavi H, Forghani M, Others. Effect of surface roughness and materials composition. J Biomater Nanobiotechnol. 2012;3(04):541.

36. Thomas TR. Trends in surface roughness. Int J Mach Tools Manuf. 1998 May 1;38(5):405–11.

37. Bala O, Arisu HD, Yikilgan I, Arslan S, Gullu A. Evaluation of surface roughness and hardness of different glass ionomer cements. Eur J Dent. 2012 Jan;6(1):79–86.

38. Madhyastha PS, Hegde S, Srikant N, Kotian R, Iyer SS. Effect of finishing/polishing techniques and time on surface roughness of esthetic restorative materials. Dent Res J . 2017 Sep;14(5):326–30.

39. da Silva RC, Zuanon ACC. Surface roughness of glass ionomer cements indicated for atraumatic restorative treatment (ART). Braz Dent J. 2006;17(2):106–9.

40. Miličević A, Goršeta K, van Duinen RN, Glavina D. Surface Roughness of Glass Ionomer Cements after Application of Different Polishing Techniques. Acta Stomatol Croat. 2018 Dec;52(4):314–21.

41. Rios D, Honôrio HM, de Araújo PA, Machado MA de AM. Wear and superficial roughness of glass ionomer cements used as sealants, after simulated toothbrushing. Pesqui Odontol Bras. 2002 Oct;16(4):343–8.

UNDER PEER REVIEW