



An in Vitro Study on Effect of Commonly used Eucalyptus and Chlorhexidine based Mouthwash on Surface Roughness of Universal Nanohybrid Composite and Light Cure Glass ionomer Cement.

¹Dr Mona Somani, ²Dr Aashray Patel, ³Dr Sweety Thumar, ⁴Dr Niraj Kinariwala, ⁵Dr Urooj, ⁶Dr Neelam Desai, ⁷Dr Chintan Joshi, ⁸Dr Vishwesh Joshi,

¹Associate professor, PhD scholar, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

²Assistant Professor, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

³Professor, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

⁴Professor, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

⁵Senior lecturer, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

⁶ Lecturer, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

⁷Professor and Head, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

⁸Assistant Professor, Department of Conservative Dentistry & Endodontics, Karnavati School of Dentistry, Karnavati University, Gandhinagar, Gujarat, India.

(Received: 01 October 2024)

Revised: 20 November 2024

Accepted: 09 December 2024)

KEYWORDS

Mouthwash,
Profilometer
, Resin
based
Composites,
Restorative
materials,
Surface
roughness.

ABSTRACT:

Introduction: The popularity of esthetic tooth-coloured restorations has increased as a result of high demands for pleasing appearance and patient concerns about the use of restorations which are not tooth coloured. These high demands led their wide use in restoring the carious and non- carious cervical lesions.

Material & Methods: Universal nanohybrid composite (3M Filtek Z250) and Light cure Glass ionomer cement (GC Fuji II LC) were used as a restorative material. Total 30 specimens were tested and divided into three groups based on different mouthwashes. Teflon mold of 8 mm diameter and a 2 mm thickness, samples of each material were prepared. Overflow of excess material was achieved by placing a transparent mylar strip. In order to ensure smoothness and light refraction, glass surface was used. Both the restorative material were light cured with LED light (Woodpecker, Mainland, China) according to manufacturer's instructions. Then the specimens were polished subsequently with coarse, medium, fine and super fine polishing disc of Super snap polishing kit (Shofu, Kyoto, Japan) according to manufacturer's instructions by using a low-speed handpiece at a rpm of approximately 12000-14000. Surface roughness was then tested using surface profilometer (Surftest 211, Mitutoyo, Tokyo, Japan).

Results: One-way analysis of variance (ANOVA) was performed. While the Wilcoxon test was used for paired comparison of the data before and after immersion. All the data were evaluated with 95% of confidence $p > 0.05$.

Conclusion: Hence within the limitations of this study, there was no significant differences between the materials before and after immersion in mouthwashes. This is of utmost importance as any surface roughness can lead to plaque accumulation and bacterial retention.



Introduction:

The popularity of aesthetic tooth-coloured restorations has increased as a result of high demand for pleasing appearance and patient's concerns about tooth-coloured restorations.[1] There has been also an increase in use of light cure materials for restorations due to its ease of manipulation and application.[2] While conventional glass ionomer cements (GIC) have widely been used in restoring the carious or non-carious cervical lesions since ages. Low thermal co-efficient expansion, biocompatibility, adherence to tooth structure, antibacterial activity, and anticariogenic capacity are all properties of GICs.[3] [4] The development of cracks and gaps, poor polishability, sensitivity to dehydration, and moisture contamination during the early phases of setting are some of its less desirable physical and mechanical characteristics. Thus, light cure GICs (GC Fuji II LC) was introduced and can be used as direct restorative material, that have overcome the early moisture sensitivity and poor mechanical qualities.[5] Nanohybrid Composites are restorative materials that bond to the tooth with a compatible bonding method and have a variety of benefits, including improved aesthetics along with a minimal preparation of the cavity. Whereas similar to this nanohybrid composite, Light cure GICs also include a resin monomer polymerization that can be activated chemically or by light in addition to the conventional acid-base reaction. More and more studies are proving that nanohybrid composites are durable material for restoring Class I, II and even Class V cavities.[6] It is necessary to isolate the tooth properly and a method of incremental layering is currently practiced. This layering of RBC enhances light penetration, enabling complete polymerization and is believed to lower the overall polymerization shrinkage. However, this technique results in the restoration voids and also is time-consuming. So, bulk-fill resin composites are developed to make the placement of direct composite restorations easier and faster. Manufacturers claim that these resin composites can be effectively photopolymerized at depths up to 4-5 mm while maintaining minimal polymerization shrinkage stress, setting them apart from all other groups of resin composites fundamentally. While the composition of the light cure GIC is similar to that of conventional GIC, however, 2-hydroxyethyl methacrylate (HEMA) is commonly used as the polymerizable resin monomer in light cure GICs. Due to its hydrophilic composition,

HEMA in light cure GICs causes a larger water uptake and swelling of the resin matrix, which may degrade the cement's mechanical properties.

Dental restorative material's surface texture, microhardness and roughness is an important factor to be taken into consideration to avoid future plaque accumulation which can further lead to porosities and degradation of restoration. Both internal and external factors can affect the surface roughness of dental materials. Rough surfaces accumulate more plaque than smooth surfaces, material is more easily worn. An increase in the roughness of restorative materials' surfaces is a precursor to bacterial colonization and a risk factor for developing gingival and periodontal diseases in the future. The longevity of tooth-coloured restorations depends on several factors, one of which is their ability to resist degradation in the oral environment. Water sorption is a diffusion-controlled process that may lead to chemical deterioration of the substance and a number of negative effects, including residual monomer release and filler-polymeric matrix debonding. This procedure may decrease the mechanical properties, as a result there is loss of hardness and thus the material becomes more soluble. The quantity of leachable, unreacted monomers is considered to be the causative factor for the solubility of resin composites.

The oral environment has a major influence on the restorative material. The use of food, beverages, liquids, or mouthwashes affects the surface roughness of the restorative material. Patients who are unable to consistently maintain acceptable levels of plaque with mechanical procedures alone can benefit significantly from the supplementary use of antimicrobial mouthrinses. Mouthwashes often contain water, antimicrobial agents, salts, and, occasionally, alcohol. The pH of mouthwashes can vary depending on the proportion of these ingredients. Mouthwashes can also cause surface deterioration and softening because they lower the oral pH, which increases composite's sorption and solubility. These acidic solutions are known to be able to alter the organic structure of resin composites. For aesthetic purposes, patient comfort, and material longevity, a restoration's surface properties are utmost important.

Aim:

To evaluate the effect of commonly used eucalyptus based (Listerine) and chlorhexidine-based mouthwashes



(Hexidine) on the surface roughness of universal nanohybrid composite (3M Filtek Z250) and light cure glass ionomer cement. (GC Fuji II LC) before and after immersion.

Material & Methods:

Total 30 specimen were tested. Two different restorative materials 3M Filtek Z250 XT and GC Fuji II LC were tested in three different mouthwashes i.e. Hexidine, Listerine and artificial saliva. Thus, in total 30 specimens were tested. These were divided into three groups based on different mouthwashes.

Group 1: Hexidine

Group 2: Listerine Group 3: Artificial Saliva

A Teflon mold of 8 mm diameter and 2 mm thickness was used to make samples of each material.

(Figure 1)

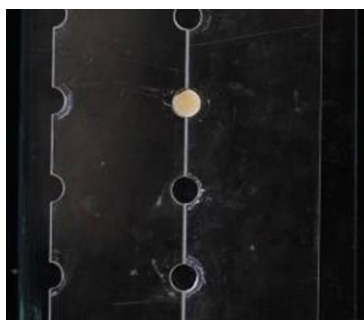


Figure 1 – Disc of a respective material made using the Teflon mold

Both the restorative materials were then polymerized with LED light (3M Elipar DeepCure-S LEDCuring Light)) according to manufacturer's instructions. (Figure 4)

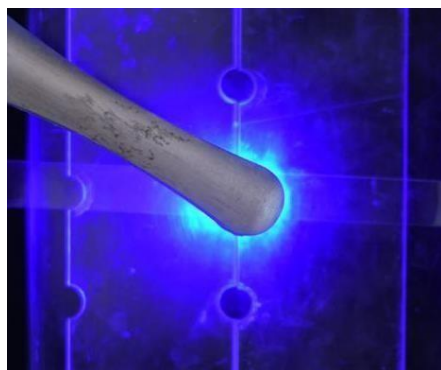


Figure 4 – Polymerization of the mold using LED light

Overflow of excess material was avoided by placing transparent mylar strip between them. (Figure2)

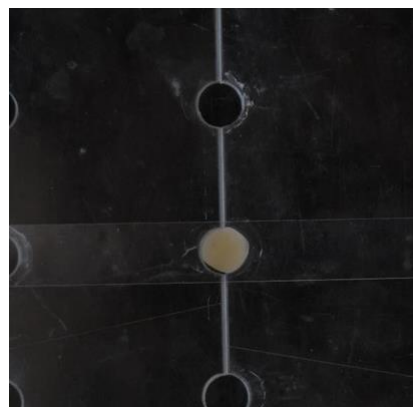


Figure 2 – Mylar Strip placed over the mold

Also, in order to ensure smoothness and light refraction, glass surface was used beneath the moulds.(Figure 3)



Figure 3 – A glass strip placed over the mold to ensure the removal of the excess



Figure 5 – Readings obtained on surface profilometer



Further, the specimens were polished subsequently with coarse, medium, fine and super fine polishing discs of Super snap polishing kit (Shofu, Kyoto, Japan) as per manufacturer's instructions by using a low-speed handpiece at a rpm of approximately 12000-14000. Then the surface roughness was tested using a surface profilometer (Surftest 211, Mitutoyo, Tokyo, Japan). the bottom surface was coded with a number for easy identification of the specimen. All the specimens were then placed in artificial saliva in sterile boxes for 12 hours to replicate clinical condition of few hours in saliva before immersion into mouthwashes.

Then 10 specimens were dipped in group 1-Hexidine group for 21min and other 10 specimens were dipped in Group 2 Listerine group for similar 21min and other 10 specimens in Group 3- artificial salivary substitute for 12 h at 37°C. This constituted one immersion cycle. Likewise, this immersion cycle was repeated 8 times which corresponds to the continuous usage of 6 months. The surface roughness of all specimens were evaluated using a profilometer. (Figure 5) The surface roughness data for each specimen was calculated by taking the arithmetic average of the measurements taken three times from each specimen, from the middle point of the specimens and

respective data were collected.

Results:

Statistical analyses were performed with SPSS version 2.0 software (SPSS Incorporated, Chicago, USA). p value of less than 0.05 was considered statistically significant for all tests. One-way analysis of variance (ANOVA) for the evaluation of surface roughness data was performed. While the Wilcoxon test was used for paired comparison of the data before and after immersion. All the data were evaluated with 95% of confidence intervals.

The mean and standard deviation of the materials before and after immersion are shown in Table

1. There were no significant differences between the materials before and after immersion in mouthwashes ($P > 0.05$). According to data, within the post immersion values the highest mean value for surface roughness was presented in 3M Filtek Z250 XT Universal nanohybrid restorative composite in Listerine (Group 2) at the end of immersion time. There were no significant differences between the surface roughness values of specimens kept in storage solution for each material.

Table 1: Surface roughness of 3M Filtek Z250 XT and GC Fuji II LC before and after immersion in different mouthwashes.

Materials		Chlorhexidine	Listerine	Artificial Saliva
3M Filtek Universal Restorative Nanohybrid Composite	Before immersion	0.81±0.39	0.79±0.44	1.21±0.20
	After immersion	1.21±0.40	1.34±0.37	1.24±0.29
GC Fuji II LC	Before immersion	1.11±0.35	1.03±0.32	1.25±0.30
	After immersion	1.32±0.41	1.33±0.37	1.29±0.35

Discussion:

Dental restorations are made of materials that resemble natural tooth structure. Restorative materials are anticipated to have physical, mechanical, and aesthetic properties similar to tooth tissues and contact enamel surfaces. Regarding the aesthetic qualities of dental restorations, surface roughness is a crucially valuable

parameter. The effect of mouthwashes on the surface roughness of nanohybrid composites and light cure glass ionomer cement is a subject of significant interest due to its potential implications for the longevity and aesthetics of restorative dental work. Several in vitro studies have sought to investigate this phenomenon and shed light on the impact of various mouthwashes on these



materials.^{[10][11][12]}

Some investigations have been done to examine the effects of mouthrinses on the surface characteristics of aesthetic restorative materials under various exposure regimes.^[11] In this study, the specimens were subjected to immersion cycles in the mouthwashes tested and artificial saliva, with each cycle consisting of complete immersion in a mouthwash for 21 min (equivalent to 3 weeks of use) and then in saliva for 12 h straight. This was done in accordance with the *in vitro* model proposed by Armas-Vega et al.^[16] Artificial saliva was employed to hydrate material specimens and to replicate washing action of the oral cavity.

According to obtained results of the current study, surface roughness does not show a significant difference between neither the mouthwashes nor materials. Usually, it is expected that 3M Filtek Z250 XT with its filler particles would have a higher surface roughness after polishing. Some studies have shown that resin modified composites with smaller particles have a higher gloss and lower surface roughness after polishing. In the present study, the values of average mean for all tested materials before and after immersion and polishing were within varied ranges. This suggests that the composition of the materials may be responsible for these differences. According to research conducted by Bollen et al.^[17] on the relationship between titanium implant Ra values and bacterial adherence, the crucial surface roughness (Ra) for bacterial colonisation is 0.2 μm . Surface roughness more than 0.2 μm is anticipated to greatly increase dental plaque accumulation, bacterial adhesion, and acidity, all of which act on material surfaces and raise the risk of caries.^[17]

Gladys et al.^[19] found that for the GICs, a material with small particle sizes (Photac Fil, mean particle size 5.56 μm) was 10 times rougher after polishing than Ionosit Fil, which had larger particles and a mean particle size of 9.3 μm . Therefore, a smoother surface is not always present in materials with minute particles. As a result, other factors such as variations in particle size, distribution, and quantity, as well as interfacial interaction between particles and the matrix, may affect how a material's surface is finished.^[20] Previous research demonstrated that the pH and acidity of material samples were related to their surface deterioration.^[21] Acidity may cause RBC materials to

erode more severely, soften polymer matrixes, affect increases in dissolving, dislodge filler particles, and diminish surface hardness. Mouthwashes contain organic acids, alcohol, detergents, emulsifiers, and other chemicals that can damage restorations and soften their surface.^[21]

Thus, with all the limitations of this study, the influence of different mouthwashes on the surface roughness of universal nanohybrid composites and light cure glass ionomer cement is a subject that requires careful consideration and thus justifying the need of this current research.

Conclusion:

Within the limitations of this study, it can be concluded that there is no statistical difference in surface roughness between the three groups. Surface roughness is one of the most crucial parameters that should be taken into consideration as it can further lead to plaque accumulation and cause deterioration of restorations. Mean value of 3M Z250 XT has been found to be highest in Group 2 of Listerine. Hence, proper finishing and polishing sequence has to be followed.

References:

- [1] Chesterman, J.; Jowett, A.; Gallacher, A.; Nixon, P. (2017). Bulk-Fill Resin-Based Composite Restorative Materials: A Review. *BDJ*, 222(5), 337–344.
- [2] Pallesen U, van Dijken J W V. A Randomized Controlled 30 Years Follow up of Three Conventional Resin Composites in Class II Restorations. *Dent Mater* 2015; 31: 1232–1244.
- [3] Saadat M, Moradian M, Mirshekari B. Evaluation of the Surface Hardness and Roughness of a Resin-Modified Glass Ionomer Cement Containing Bacterial Cellulose Nanocrystals. *Int J Dent*. 2021 Dec 11;2021:8231473.
- [4] Wiegand A., Buchalla W., Attin T. Review on Fluoride-Releasing Restorative Materials-Fluoride Release and Uptake Characteristics, Antibacterial Activity and Influence on Caries Formation. *Dental Materials*. 2007;23(3):343–362.
- [5] Peez R., Frank S. The Physical-Mechanical Performance of the New Ketac Molar Easymix Compared to Commercially Available Glass



- Ionomer Restoratives. *Journal of Dentistry* . 2006;34(8):582–587.
- [6] Demarco F F, Corrêa M B, Cenci M S, Moraes R R, Opdam N J. Longevity of Posterior Composite Restorations: Not Only a Matter of Materials. *Dent Mater* 2012; 28: 87–101.
- [7] Marovic, Danijela; Tauböck, Tobias T.; Attin, Thomas; Panduric, Vlatko; Tarle, Zrinka (2015).
- [8] Monomer Conversion and Shrinkage Force Kinetics of Low-Viscosity Bulk-Fill Resin Composites. *Acta Odontologica Scandinavica*, 73(6), 474–480.
- [9] Soygun K., Soygun A., Dogan M. C. The Effects of Chitosan Addition to Glass Ionomer Cement on Microhardness and Surface Roughness. *Journal of Applied Biomaterials Functional Materials*. 2021;19.
- [10] Da Silva EM, Almeida GS, Poskus LT, Guimarães JG. Relationship between the Degree of Conversion, Solubility and Salivary Sorption of a Hybrid and a Nanofilled Resin Composite. *J Appl Oral Sci*. 2008 Mar-Apr;16(2):161-6.
- [11] Barnett, Michael L. (2003). The Role of Therapeutic Antimicrobial Mouthrinses in Clinical Practice. *The Journal of the American Dental Association*, 134(6), 699–704.
- [12] Jyothi KN, Crasta S, Venugopal P. Effect of Five Commercial Mouth Rinses on the Microhardness of a Nanofilled Resin Composite Restorative Material: An in Vitro Study. *J Conserv Dent* 2012;15:214-7.
- [13] Trauth KG, Godoi AP, Colucci V, Corona SA, Catirse AB. The Influence of Mouthrinses and Simulated Tooth Brushing on the Surface Roughness of a Nanofilled Composite Resin. *Braz Oral Res* 2012;26:209-14.
- [14] Miranda Dde A, Bertoldo CE, Aguiar FH, Lima DA, Lovadino JR. Effects of Mouthwashes on Knoop Hardness and Surface Roughness of Dental Composites after Different Immersion Times. *Braz Oral Res*. 2011 Mar-Apr;25(2):168-73.
- [15] Ferreira Rde, S., Lopes, G. C., & Baratieri, L. N. (2004). Direct Posterior Resin Composite Restorations: Considerations on Finishing/Polishing. *Clinical Procedures. Quintessence International*, 35(5), 359–366.
- [16] Cavalcanti AN, Mitsui FH, Ambrosano GM, Mathias P, Marchi GM. Effect of Different Mouthrinses on Knoop Hardness of a Restorative Composite. *Am J Dent* 2005;18:338-40.
- [17] Armas-Vega A, Casanova-Obando P, Taboada-Alvear MF, Aldas-Ramirez JE, Montero-Oleas N, Viteri-Garcia A. Effect of Mouthwashes on the Integrity of Composite Resin and Resin Modified Glass Ionomer: In Vitro Study. *J Clin Exp Dent* 2019;11:179-84.
- [18] Bollen CM, Papaioanno W, Van Eldere J, Schepers E, Quirynen M, van Steenberghe D. The Influence of Abutment Surface Roughness on Plaque Accumulation and Peri-Implant Mucositis. *Clin Oral Implants Res* 1996;7:201–211.
- [19] Reis AF, Giannini M, Lovadino JR, Ambrosano GM. Effects of Various Finishing Systems on the Surface Roughness and Staining Susceptibility of Packable Composite Resins. *Dent Mater* 2003;19:12-18.
- [20] Gladys S, Van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Comparative Pysico- Mechanical Characterization of New Hybrid Restorative Materials with Conventional Glass- Ionomer and Resin Composite Restorative Materials. *J Dent Res* 1997;76:883-894.
- [21] Reddy PS, Tejaswi KS, Shetty S, Annapoorna BM, Pujari SC, Thippeswamy HM. Effects of Commonly Consumed Beverages on Surface Roughness and Color Stability of the Nano, Microhybrid and Hybrid Composite Resins: An in Vitro Study. *J Contemp Dent Pract* 2013;14:718-23.
- [22] Carpenter G, Pramanik R, Proctor G. An in Vitro Model of Chlorhexidine-induced Tooth Staining. *J Periodontal Res* 2005;40:225-30.