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Original Article

Impact of Water Flossers on Microleakage in Self-Adhesive Resin Cement and Resin-Modified Glass Ionomer Cement

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ABSTRACT

The accumulation of plaque, a complex biofilm forming on the hard surfaces of teeth, is a major factor in the development of periodontal disease and dental caries. Plaque biofilms are implicated in a variety of oral health problems, including these common conditions. To preserve oral health, various mechanical plaque control methods are used to minimize plaque buildup. This study investigated the effect of water flossing on marginal microleakage in RMGI. The research follows four key stages: sample collection, preparation, scanning, and cementation. The process involves flossing, thermocycling, and data collection. A total of 20 teeth were cemented using Rely-X and RMGIC cement, and then subjected to water flossing to assess its effect on marginal microleakage. Dye penetration was assessed and analyzed to determine the extent of leakage. The findings indicate a slight change in the margins of crowns cemented with Rely-X and RMGIC, with Rely-X showing a lower degree of microleakage.

Keywords: Rely-X, Water floss, Resin cement, Margins, Zirconia, GIC cement

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Introduction

The formation of plaque, a complex biofilm that accumulates on the hard surfaces of teeth, is a leading cause of dental caries and periodontal disease. These biofilms contribute to various oral health issues, including periodontal disease and tooth decay [1]. To promote oral health, several mechanical plaque control methods are available to minimize plaque accumulation [2]. Traditionally, dental floss and toothbrushes have been utilized to clean supragingival plaque, as well as marginal and interproximal areas. Water flossing has emerged as an alternative approach to reducing plaque in marginal regions. The first commercially available water flosser was introduced in

1962 [3]. Multiple studies have demonstrated the effectiveness of water flossing in eliminating plaque biofilm. Research conducted in 2009 revealed that water flossing successfully removed 99.99% of salivary biofilms [4]. Furthermore, additional studies suggest that water flossing is beneficial for individuals with specific oral care needs, such as those with dental braces, crowns, or bridges, as it enhances the removal of biofilms from hard-to-reach areas, ultimately improving overall oral hygiene [5].

The effectiveness of water flow is primarily attributed to the combination of pressure and pulsation. These factors create alternating compression and decompression phases, which help dislodge debris and plaque biofilms from interdental and subgingival regions [6]. Recent research has confirmed the safe application of water flossers on various resin composites, showing no significant alterations in surface roughness or color changes [7].

This study investigates how water flossers influence microleakage at the margins of crowns sealed with resin-modified glass ionomers (RMGI) and self-adhesive resin cement. The null hypothesis proposes that there is minimal variation in marginal microleakage between crowns cemented with RMGIC and Rely-X cement.

Materials and Methods

This study is structured into four primary phases: sample collection, preparation, scanning, and cementation. Additionally, the process includes flossing and thermocycling for data collection.

Sample collection was conducted following the board's approval for non-human research. Human premolar teeth were obtained from the Oral and Maxillofacial Surgery Department at Riyadh Elm University. As illustrated in **Figure 1**, each tooth underwent examination with a dental explorer to detect caries and was further inspected under a digital microscope (VHX 600, Keyence, Osaka, Japan) using a 50x lens to identify any fractures or fracture lines. Teeth exhibiting decay, cracks, or structural defects were excluded from the study. Consequently, a total of 20 samples were selected for further analysis.

During the second phase, tooth samples underwent manual preparation following a standardized crown preparation protocol. All walls were uniformly reduced to a depth of 1.5 mm, while the occlusal surface was reduced by 2 mm. The walls were tapered at an angle ranging between 4° and 8°. A circumferential chamfer finish line was created, with a gingival margin reduction of 0.5 mm.

Next, each tooth was scanned using an intraoral scanner (TRIOS3, 3Shape TRIOS A\S, Holmens Kanal, Copenhagen, Denmark). The digital impressions were then sent to a DentTech laboratory (Custom Milling Center, Riyadh, KSA) for the fabrication of zirconia crowns, designed with a wall thickness of 0.6 mm and a cement space of 100 µm (Rodenbacher Chaussee 4, 63457 Hanau-Wolfgang, Germany). To ensure stability, the samples were embedded in acrylic resin base blocks **(Figure 1)**.

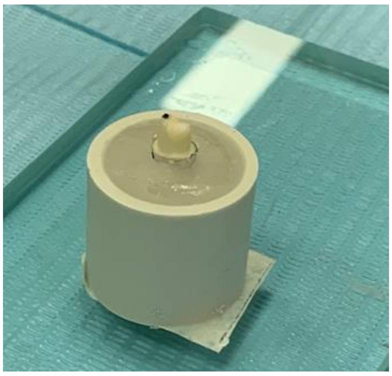
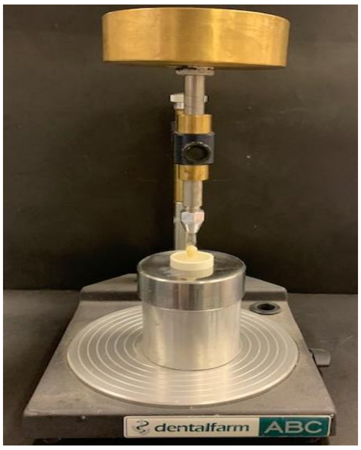


Figure 1. Teeth embedded in acrylic

After fabrication, the crowns were fitted onto the tooth samples and then divided into 2 experimental groups. The first group consisted of 10 samples cemented using self-adhesive resin cement (RelyX Unicem Aplicap, 3M), while the second group included 10 samples secured with resin-modified glass ionomer (RMGI) cement (Ketac Cem Aplicap, 3M). Within each group, the samples were further subdivided, with 5 designated as control cases and the remaining 5 assigned as study cases **(Figure 2)**.

Figure 2. Teeth samples

During the cementation process, the crowns were seated using a surveyor with a customized weight apparatus, applying 2 kg of lead to simulate thumb pressure. Following this, each side was light-cured for 20 seconds, with a total curing time of 1 minute at room temperature **(Figure 3)**. The samples were then stored in distilled water at 37 °C for 24 hours.



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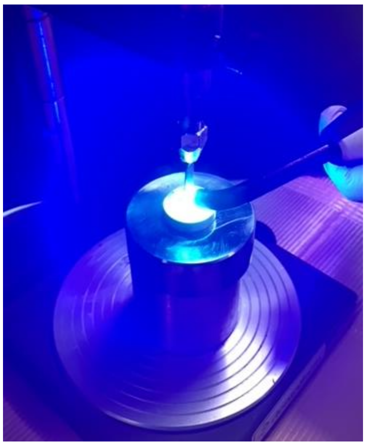

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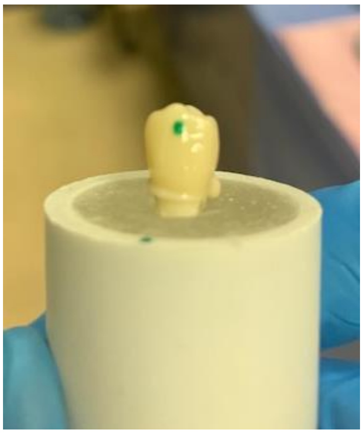


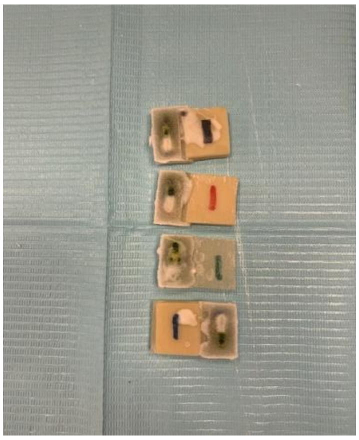
c)

Figure 3. Samples after cementation.

Water flossing was performed at maximum power (100 psi) on all study samples, with the water stream directed perpendicularly to the tooth surface for thirty minutes (Aquarius Water Flosser, WATER PIK, FT. COLLINS, CO, USA).

To replicate an oral environment, the samples underwent thermocycling, consisting of ten thousand cycles with water temperatures alternating between 5 °C and 55 °C. This process was conducted both before and after the 30-minute water flossing session, simulating the effects of five years of daily one-minute water flossing [8]. Each cycle lasted 1.35 minutes, with a 30-second immersion in each temperature bath.

Following thermocycling, the samples were submerged in a 2% methylene blue dye solution for 48 hours. A dental sectional disc device was then used to bisect the samples buccolingually through the center of the crown for further analysis (Abrasive Discs, Zermatt, Buehler, Lake Bluff, IL, USA). Each sectioned sample was examined under a light microscope with a 50x lens (KH-7700, Hirox, Suginami-Ku, Tokyo, Japan). At last, an integrated image analysis system at 50× magnification was used to measure dye penetration from the external crown surface to the most precise area of each sample **(Figure 4)**.



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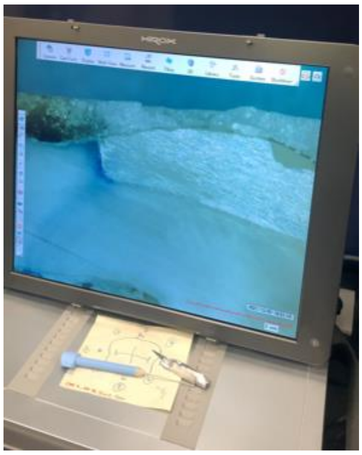

b)

Figure 4. Samples after sectioning and measuring the dye penetration

Results and Discussion

A total of 20 teeth were examined to assess the impact of water flossing on microleakage at crown margins using two distinct types of cement. Statistical analysis (SPSS) of dye penetration data led to the acceptance of the null hypothesis. The results indicate a slight alteration in the marginal area when water floss was applied to GIC and Rely-X cement, as measured by dye penetration.

Table 1 presents a summary of the statistical analysis results. The average microleakage in the GIC group was 2881.6 ± 7.87%, while the control GIC group showed a mean of 1940 ± 4.31%. In comparison, the average microleakage for Rely-X was 1352.2 ± 5.03%, with the Rely-X control group having a mean of 911.8 ± 2.43%.

Table 1. Statistical analysis of the data

Paired samples statistics					
Paired samples	**Cement type**	**Mean**	**N**	**Std. deviation**	**Std. error mean**
Pair 1	RMGIC	2881.6000	5	787.41273	352.14168
	RMGIC_Control	1940.4000	5	431.61012	193.02192
Pair 2	Rely_X	1352.2000	5	503.40759	225.13072
	Rely_X_Control	911.8000	5	243.47834	108.88682

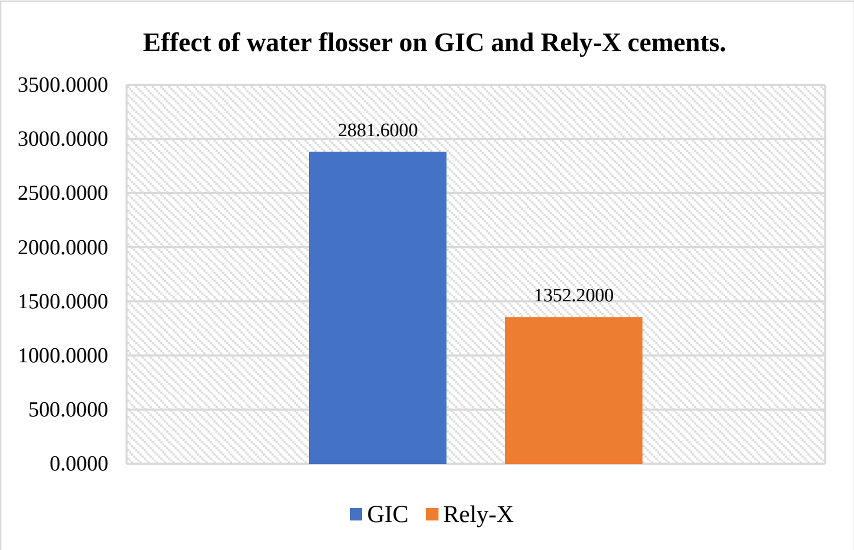

Figure 5. Comparison of the effect of water floss on GIC and Rely-X cement

Both cement types exhibited a slight change in the marginal areas of the crowns. However, the RMGIC cement group demonstrated higher microleakage compared to the Rely-X cement group, likely due to the weaker bond strength between GIC cement and dentin compared to Rely-X cement **(Figure 5)** [9]. A study by Piwowarczyk on microleakage in various types of cement, including Rely-X and GIC, found that Rely-X cement exhibited the least microleakage in a typical oral environment without the use of external tools [10]. Future studies could explore the impact of water flossers on microleakage in different cements and crown types. Additionally, increasing the sample size of teeth could lead to more definitive conclusions regarding the extent of the gap created. Another avenue for investigation could involve comparing the effects of water flossers versus traditional dental floss on crown cement, to identify the safest method for cleaning interproximal areas.

The study investigated the effect of water flossing on microleakage at crown margins using two different cement types, involving a total of 20 teeth. The statistical analysis of dye penetration data (SPSS) supported the null hypothesis. The findings revealed a slight change in the marginal area when water floss was applied to GIC and Rely-X cement, as assessed by dye penetration.

Table 1 summarizes the statistical data from this research. The mean microleakage for the GIC group was 2881.6 ± 7.87%, while the control group showed a mean of 1940 ± 4.31%. For the Rely-X and Rely-X control groups, the averages were 1352.2 ± 5.03% and 911.8 ± 2.43%, respectively. **Figure 5** illustrates the marginal microleakage differences between GIC and Rely-X cements.

The type of composite material did not have a statistically significant effect on the change in surface roughness scores ($F(4,30) = 2.390$, $P = 0.073$, partial $\eta 2 = 0.242$). However, water-jet flossing showed a significant impact ($F(2,30) = 25.981$, partial $\eta 2 = 0.634$, $P < 0.001$). A significant relationship was found between the water-jet flossing and composite materials regarding the decrease in surface roughness ($F(8,30) = 2.454$, $P = 0.036$, partial $\eta 2 = 0.396$).

In this study, both cement types showed a slight variation in marginal crown microleakage. However, the RMGIC cement groups demonstrated more microleakage compared to the Rely-X cement group, as the bond between GIC cement and dentin is weaker than that of Rely-X cement. A study by Piwowarczyk on various cement types, including Rely-X and GIC, found that Rely-X cement exhibited the least microleakage in a typical oral environment without external instruments [10].

Despite following a standardized polishing technique, the initial surface roughness of the various composite materials differed from the previous study. These variations could be attributed to the intrinsic properties of the composites, such as the filler characteristics (type, size, shape, hardness, and particle arrangement), the resin matrix composition, the polymerization rate, and the bonding efficiency at the filler/matrix interface. The surface roughness levels in this study align with those of earlier investigations, where roughness values ranged from 0.3 to 1.2 µm [8, 11].

In earlier research, Ceram X and Estelite Sigma specimens in the 100 Psi treatment group showed a significantly larger increase in surface roughness compared to Z350 specimens, according to pairwise comparison: $F(2,30) = 13.467$, $P < 0.001$, partial $\eta 2 = 0.473$; $F(2,30) = 17.623$, $P < 0.001$, partial $\eta 2 = 0.540$, respectively. The analysis of simple main effects for composite type revealed a statistically important difference in the change in surface roughness scores across water-jet flossing groups for Ceram X and Estelite Sigma. However, this difference wasn't significant for the other composite materials [12, 13].

Water flossing did not influence the color stability of the materials used, regardless of the composite type or water pressure. No samples showed noticeable color change ($\Delta E \leq 2$). This finding aligns with previous studies indicating that water absorption and storage alone do not significantly alter the color of composites [14, 15]. Additionally, while surface roughness can impact the amount, direction, and quality of reflected light, potentially affecting color measurements, the variations in surface roughness for each sample in this study were less than the wavelength of visible light (approximately 0.5 µm). As a result, even minor changes in surface roughness did not significantly alter the spectrophotometric readings [16, 17].

A prior study found that smaller filler sizes resulted in lower surface roughness values after abrasion polishing [18]. Consequently, nano-filled composites exhibited lower roughness than submicron and micro-hybrid composites. Given the variations in these types of studies, the roughness values observed in this study were higher than those in others. This discrepancy may be attributed to factors related to technique, which are prone to errors during the manufacturing, polishing, measurement, or specimen handling processes [19].

After simulating five years of water-jet flossing, no significant color alterations were observed. Only the two composites with spherical filler specimens in the 100 Psi group exhibited noticeable increases in surface roughness [20, 21]. The roughness of these composites was greater than that of the nano-filled composite, but the differences were still within clinically acceptable limits [7, 22].

Future studies could examine how water flossing affects microleakage in different cement types and crowns. Additionally, increasing the sample size could lead to a more reliable understanding of the gap formation. Another potential avenue for research could be a comparison between water flossers and traditional dental floss in terms of their impact on crown cement, determining the most effective method for cleaning interproximal areas safely.

Conclusion

In conclusion, the use of a water flosser on crowns cemented with Rely-X and GIC led to marginal microleakage, potentially contributing to the development of caries and periodontal disease. Therefore, it is advised to use water flossers cautiously to safeguard the integrity of crowns.

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Conflict of Interest: None

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Ethics Statement: Ethical approval for this study was granted by the REU Ethical Committee (FRP/2021/345/431/451).

References

1. Jakubovics NS, Goodman SD, Mashburn-Warren L, Stafford GP, Cieplik F. The dental plaque biofilm matrix. Periodontology 2000. 2021;86(1):32-56.

2. Mandal A, Singh DK, Siddiqui H, Das D, Dey AK. New dimensions in mechanical plaque control: an overview. Indian J Dent Sci. 2017;9(2):133.
3. Bertl K, Edlund Johansson P, Stavropoulos A. Patients' opinion on the use of 2 generations of power-driven water flossers and their impact on gingival inflammation. Clin Exp Dent Res. 2021;7(6):1089-95.
4. Salles MM, de Cássia Oliveira V, Macedo AP, Silva-Lovato CH, de Freitas de Oliveira Paranhos H. Effectiveness of brushing associated with oral irrigation in maintenance of peri-implant tissues and overdentures: clinical parameters and patient satisfaction. J Oral Implantol. 2021;47(2):117-23.
5. Goyal CR, Qaqish JG, Schuller R, Lyle DM. Evaluation of the addition of a water flosser to manual brushing on gingival health. J Clin Dent. 2018;29(4):81-6.
6. Abdellatif H, Alnaeimi N, Alruwais H, Aldajan R, Hebbal MI. Comparison between water flosser and regular floss in the efficacy of plaque removal in patients after single use. Saudi Dent J. 2021;33(5):256-9.
7. Alharbi M, Farah R. Effect of water-jet flossing on surface roughness and color stability of dental resin-based composites. J Clin Exp Dent. 2020;12(2):e169-77. doi:10.4317/jced.56153
8. Jaramillo-Cartagena R, López-Galeano EJ, Latorre-Correa F, Agudelo-Suárez AA. Effect of polishing systems on the surface roughness of nano-hybrid and nano-filling composite resins: a systematic review. Dent J. 2021;9(8):95.
9. Vivek VJ, Venugopal P, Divakar N, Bharath S, Sarin K, Mohammed N. Comparison of zirconia to dentin bonding using resin-based luting cements and resin-modified glass-ionomer cement: *In vitro*. J Pharm Bioallied Sci. 2022;14(Suppl 1):S460-3. doi:10.4103/jpbs.jpbs_779_21
10. Mazumdar P, Das A, Das UK. Comparative evaluation of microleakage of three different direct restorative materials (silver amalgam, glass ionomer cement, cention n), in class II restorations using stereomicroscope: an: in vitro: study. Indian J Dent Res. 2019;30(2):277-81.
11. Lefever D, Krejci I, Ardu S. Laboratory evaluation of the effect of toothbrushing on surface gloss of resin composites. Am J Dent. 2014;27(1):42-6.
12. Babina K, Polyakova M, Sokhova I, Doroshina V, Arakelyan M, Novozhilova N. The effect of finishing and polishing sequences on the surface roughness of three different nanocomposites and composite/enamel and composite/cementum interfaces. Nanomaterials. 2020;10(7):1339.
13. Zhang L, Yu P, Wang XY. Surface roughness and gloss of polished nanofilled and nanohybrid resin composites. J Dent Sci. 2021;16(4):1198-203.
14. Da Silva JD, Park SE, Weber HP, Ishikawa-Nagai S. Clinical performance of a newly developed spectrophotometric system on tooth color reproduction. J Prosthet Dent. 2008;99(5):361-8.
15. Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. Dent Mater. 1997;13(4):258-69.
16. Kamonkhantikul K, Arksornnukit M, Lauvahutanon S, Takahashi H. Toothbrushing alters the surface roughness and gloss of composite resin CAD/CAM blocks. Dent Mater J. 2016;35(2):225-32.
17. Turssi CP, Ferracane JL, Vogel K. Filler features and their effects on wear and degree of conversion of particulate dental resin composites. Biomaterials. 2005;26(24):4932-7.
18. Nasim I, Neelakantan P, Sujeer R, Subbarao CV. Color stability of microfilled, microhybrid and nanocomposite resins--An in vitro study. J Dent. 2010;38:e137-42.
19. Farah RI, Elwi H. Spectrophotometric evaluation of color changes of bleach-shade resin-based composites after staining and bleaching. J Contemp Dent Pract. 2014;15(5):587-94.
20. Kaizer MR, de Oliveira-Ogliari A, Cenci MS, Opdam NJ, Moraes RR. Do Nano fill or submicron composites show improved smoothness and gloss? A systematic review of in vitro studies. Dent Mater. 2014;30(4):e41-78.
21. Azer AS. The effect of ultrasonic scaling on microleakage around zirconia crown margins luted with two resin cements. Egypt Dent J. 2020;66(4):2481-9.
22. Sarafianou A, Iosifidou S, Papadopoulos T, Eliades G. Color stability and degree of cure of direct composite restoratives after accelerated aging. Oper Dent. 2007;32(4):406-11.