Comparative Evaluation of Microleakage of Different Luting Cements for Prefabricated Pediatric Zirconia Crowns

Lina M. Abd El Azim

Magda A. ElMalt

Nouralhouda F. Abd-Allah

Comparative Evaluation of Microleakage of Different Luting Cements for Prefabricated Pediatric Zirconia Crowns

Lina M. Abd El Azim [a,b,c,*], Magda A. ElMalt [a], Nouralhouda F. Abd-Allah [a]

[a] Department of Pedodontics and Oral Health, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt
[b] Faculty of Dentistry MSA University, Cairo, Egypt
[c] Egyptian Ministry of Health, Cairo, Egypt

Abstract

Objective: This study aimed to Compare microleakage of conventional glass ionomer cement, highly Viscous glass ionomer cement, Resin cement and Resin modified glass ionomer cement (RMGIC) with prefabricated posterior NuSmile ZR crowns. **Patients and methods:** Fourty prefabricated Nusmile zirconia crowns for lower primary second molars were cemented by different four types of cement. Group I: 10 of crowns were cemented by Ketac cement, group II: 10 of crowns were cemented by Fuji IX cement, group III: 10 of crowns were cemented by Panavia cement and group IV: 10 of crowns were cemented by Fuji II cement after thermocycling microleakage was evaluated to all of them. **Results:** The results of ANOVA meaning there was a highly significant difference between groups, especially between GII (High packable GIC) which has the highest mean of microleakage and G III (Resin cement) which has the lowest mean of microleakage. **Conclusion:** After thermocycling Resin cement (group III) showed the least microleakage with prefabricated Nusmile zirconia crowns, RMGIC Group (IV) showed more microleakage than Resin Cement,conventional GIC (group I)showed more microleakage than Resin and RMGIC and group II high packable GIC (fuji IX) had the highest microleakage.

Keywords: Fuji II, Ketac, Microleakage, Nusmile zirconia crowns, Panavia

1. Introduction

Primary molar crowns were prefabricated and might be found in a range of sizes and materials to cover decaying or malformed teeth. Crowns made of zirconia had a very high success rate in terms of their longevity, capacity to retain their fit, and little impact on gingival health, according to case reports and clinical research [1,2].

Crowns made of zirconia that had not been tainted with blood or saliva had a stronger bond with cement, which was another crucial consideration. Ingeniously addressing this issue, Nusmile crowns proposed a pre-cement trial fitting using a try-in-pink crown before cementing the permanent restoration [3].

The difficulty of using prefabricated zirconia crowns to restore primary teeth was that they must passively fit on the prepared tooth, relying in their retention on the luting cement alone. The reliable gingival condition surrounding crowns was a contributing factor [4].

Indirect restorations relied heavily on dental luting cements for their effectiveness. In addition to filling the space between the tooth and indirect repair, luting cement also chemically or mechanically bonds the restoration to the tooth preparation, preventing it from coming loose during use. The aesthetic all-ceramic restoration's hue might also be enhanced by this attribute [5].

The ability of cement to bond was determined by its mechanical, physical, and chemical properties, which mostly depended on its chemical makeup. Good sealants had good mechanical properties, were stable in size, stuck well to the tooth structure,

Received 1 June 2023; accepted 15 October 2023.
Available online 5 October 2024

* Corresponding author at: Al Haram, Al Giza, 12556, Egypt.
E-mail address: Linamahmoudabdelazim@gmail.com (L.M. Abd El Azim).

https://doi.org/10.58675/2974-4164.1628

had a thin film thickness, didn't dissolve easily in oral fluids, and had the same coefficient of thermal expansion as the coronal tooth structure [6].

One of the most important ways to evaluate the luting cement's performance is to test for microleakage. It was the most frequent cause of failure to recover after treatment including infection, which could lead to postoperative discomfort, recurrent caries, or pulp damage [7].

This led to conduct of the present research, which compared the microleakage of four cement types when used with prefabricated nusmile zirconia crowns. The null hypothesis of this study was there would not be a difference in the levels of microleakage between different types of GIC cements.

2. Patients and methods

Ethical approval with code (REC-PE-23-04) was obtained from the research and ethics Committee of the Faculty of Dental Medicine for Girls, Al-Azhar University.

2.1. Sample size calculation

The calculation was performed with the CDC Epi Info program version 7.2.0.1 (Atlanta, USA), assuming a power of 80% and alpha = 0.05 to determine whether or not there was a statistically significant variation in the microleakage conventional glass-ionomer cement, highly viscous glass ionomer cement (HVGIC), resin glass ionomer cement and resin modified glass-ionomer cement (RMGIC) with prefabricated posterior NuSmile ZR crowns. A total sample of 32 primary posterior ZR NuSmile prefabricated crowns. (eight each group) was needed based on an estimated mean microleakage score of ZR NuSmile crowns of 0.8 ± 1.5 and 2.2 ± 0.6 when cemented compared with microleakage score of EZ Crowns 1.5 ± 1 and 2.1 ± 0.3 that had been cemented [8].

2.2. Epoxy models fabrication

A total of 40 epoxy resin (CMB, Egypt) models of lower second primary molar were fabricated for study [9]. Forty Nusmile prefabricated zirconia crowns, size 5, were cemented with epoxy models, all of them were same size for standardization.

2.3. Cementation of crowns

The 40 epoxy models and crowns were divided randomly into four groups.

Group I: 10 of zirconia crowns were cemented on epoxy models by conventional glass ionomer (Ketac cement: powder and liquid, 3 M ESPE, UK).

Group II: 10 zirconia crowns were cemented on epoxy models by HVGIC (Fuji IX fast capsules cement, GC, Tokyo, Japan).

Group III: 10 zirconia crowns were cemented on epoxy models by resin cement (Panavia SA Automix plus cement, Kuraray America, Inc.) translucent shade.

Group IV: 10 zirconia crowns cemented on epoxy models by RMGIC (Fuji II capsules cement, GC America Inc.).

All of crowns were cemented to epoxy models according to each cement's manufacture brochure and after setting the excess was removed.

Models with cemented crowns were thermo-cycled 500 cycles [10] using (SD mechatronics thermocycler, Westerham, Germany). Models were immersed in cold water bath at 5° and then immersed in hot water bath at 55° then dwell time 30 s [11].

2.4. Microleakage test

Following a 24-h incubation period at 37 °C, the models were submerged in a solution of 2% methylene blue dye (Biopharma, Egypt), washed for 10 min to remove excess dye, and allowed to dry for 6 h before dye fixation [10]. The samples were cut with a diamond wheel (Isomet 4000, Buehler, precision saw USA) to create bucco-lingual sections. Inspecting the models under a stereomicroscope, one portion of each model was painstakingly cleaned with alcohol to remove the cutting debris. Dye penetration was measured using a Nikon MA 100 stereomicroscope (Nikon, Japan) (Fig. 1). Omnimet (Buehler, USA) was used for the image analysis, and measurements were taken in micrometers (m) [11].

2.5. Statistical analysis

The data were analyzed statistically using the one-way ANOVA test and the post hoc test for

Fig. 1. Stereomicroscope and image analysis for evaluation of microleakage.

comparisons between the groups, a *P* value of less than 0.05 was regarded as significant, and a *P* value of less than 0.001 indicated strong statistical significance. The data normality was checked using the Shapiro–Wilk test. Data were analyzed by SPSS (IBM Co., USA) software [12].

3. Results

3.1. Basic descriptive statistics

The statistical analysis was applied to four groups with a total sample size of 40 samples; each group was represented by 10 samples. Table 1 shows the results of basic descriptive statistics, According to the Shapiro–Wilk test for results, the data was normally distributed ($P \leq 0.05$). Group II shows the highest mean of microleakage (2904.17 ± 1261.52 μm) ranged from 752.34 μm to 4103.72 μm, while group III achieved the lowest mean (276.69 ± 57.18) ranged from 218.77 μm to 375.03 μm.

3.2. Inter-group comparison (ANOVA)

According to the One-way ANOVA test, the overall *P*-value was statistically highly significant (*P* value $\leq$ 0.001). The results of ANOVA mean there was a highly significant difference between groups, especially between GII (HVGIC) which has the highest mean of microleakage (2904.17 ± 1261.52 μm), and GIII (resin cement) which has the lowest mean of microleakage (276.69 ± 57.18 μm). Fig. 2: bar chart depicting the mean and SD of microleakage (μm) for all the studied groups.

Figures showed different microleakage in (μm) of prefabricated zirconia crowns with different cements after thermocycling using a stereomicroscope and omniment Buhler image analysis (Figs. 3–6).

4. Discussion

The present study followed a standard protocol to assess the microleakage of bonded restoration materials in *in-vitro* conditions by submitting models to thermo-cycling, which simulated *in vivo* aging by

Fig. 3. Fuji II.

Table 1. Basic descriptive statistics of microleakage (μm) results for all groups.

Group	Mean	SD	Minimum	Maximum	Median	Normality
GI: Control group	1517.21	803.52	803.60	3607.81	1333.54	0.017
GII: High viscous GIC	2904.17	1261.52	752.34	4103.72	3363.64	0.016
GIII: Resin cement	276.69	57.18	218.77	375.03	249.12	0.048
GIV: Resin modified cement	665.40	147.31	456.96	890.30	623.61	0.044

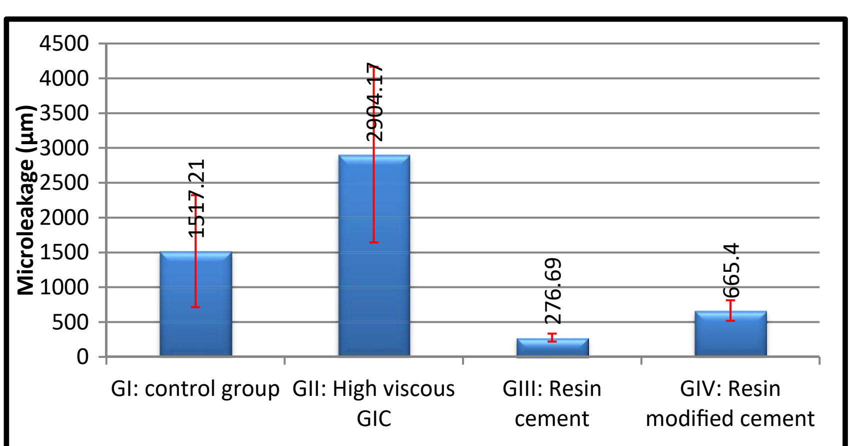

Fig. 2. Bar chart depicting the mean and SD of microleakage (μm) for all the studied groups.

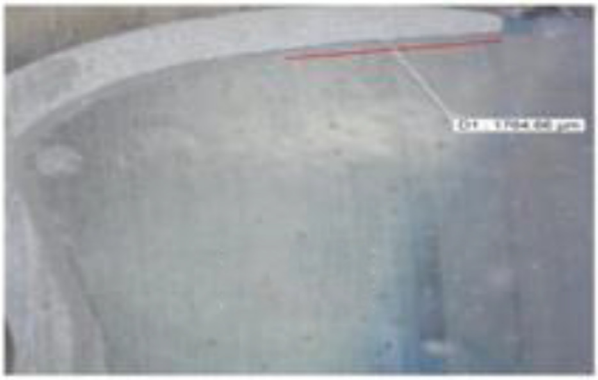

Fig. 4. Ketac cement.

Fig. 5. Panavia cement.

Fig. 6. Fuji IX.

exposing bonded materials to hot and cold temperatures at regular intervals [13]. In this work, microleakage was measured using the dye penetration technique which had become the standard due to its ease of use and reliability [7].

Traditional GIC restorative cement (ketac) was shown to have considerable microleakage in this investigation. The inability of the material to sustain thermal stresses may be to blame. As another restorative material, traditional GIC was the most susceptible to moisture during the earliest stages of the placement process [14]. Microleakage was reported to be greatest in traditional GIC compared with the other GIC variations (RMGIC) as in previous investigations [8]. This present study is in contrast with previous study that conventional RMGIC showed more microleakage than GIC [15].

In the previous study, coordination was found with the result of the current study that was Fuji IX in showed more microleakage than conventional glass-ionomer cement and RMGIC [16]. This study was in contrast with a previous study that showed Fuji IX had less microleakage than RMGIC [17].

This study's results showed that crowns cemented by Resin cement (Panavia SA Automix plus cement) scored the least microleakage. It had coordination with previous study that compared (resin cement) with RMGIC and GIC [18]. Other previous studies were in contrast with this study that showed resin cement had higher microleakage than RMGIC [19].

The findings of this research assisted doctors to choose a (panavia SA autiomix resin cement material) that provided the highest resistance for microleakage when compared with other cements, even if *in vitro* testing may have limited capacity to predict clinical performance.

4.1. Conclusion

Under the conditions of this study, the following could be derived that resin cement (panavia SA automix plus cement) had least microleakage but the high packable GIC (Fuji IX) had the highest microleakage. RMGIC (Fuji II) and conventional GIC (ketac) cement showed moderate microleakage.

4.2. Recommendations

Controlled clinical studies are necessary to draw a definite conclusion of microleakage of panavia SA auto-mix plus cement restorative material

Ethics information

Ethical approval with code (REC-PE-23-04) was obtained from the research and ethics Committee of the Faculty of Dental Medicine for Girls, Al-Azhar University.

Funding

This study have no funding.

Biographical information

This study was conducted at Department of Pedodontics and Oral Health, Faculty of Dental Medicine for Girls, Al-Azhar University, Cairo, Egypt.

Conflicts of interest

There are no conflicts of interest.

Acknowledgments

Special thanks to Al Azhar dental lab at Faculty of dentistry for Girls in Cairo, those who provided facilities and equipment in laboratory steps.

References

[1] Azab MM, Moheb DM, El Shahawy OI, Rashed MA. Influence of luting cement on the clinical outcomes of zirconia pediatric crowns: a 3-year split-mouth randomized controlled trial. Int J Paediatr Dent 2020;30:314–22.
[2] Alamoudi RA, Walia T, Debaybo D. Evaluation of the clinical performance of nusmile pedodontics zirconia crowns in pulp-treated primary teeth—2 years follow-up study. Eur J Dermatol 2022;23:82–90.
[3] Hamrah MH, Mokhtari S, Hosseini Z, Khosrozadeh M, Hosseini S, Ghafary ES, et al. Evaluation of the clinical, child, and parental satisfaction with zirconia crowns in maxillary primary incisors: a systematic review. Int J Dent 2021;2021: 1–6.
[4] Rosato LA, Chen JW, Roggenkamp CL, Su JM. Retentive strengths for prefabricated primary molar zirconia crowns using five different cements. Taiwan J Pediatr Dent 2018;18: 127–35.
[5] Falacho RI, Marques JA, Palma PJ, Roseiro L, Caramelo F, Ramos JC, et al. Luting indirect restorations with resin cements versus composite resins: effects of preheating and ultrasound energy on film thickness. J Esthetic Restor Dent 2022;34:641–9.
[6] Mohajerfar M, Nouri NN, Hooshmand T, Beyabanaki E. Microleakage of different temporary luting agents used for cementing provisional restorations on custom cast posts and cores. Dent Res J 2021;18:22.
[7] Elbieh AY, Othman HI, Haggag KM. Microleakage of temporary crowns with different cement gap. AJDS 2021;1: 2427–31.
[8] Stepp P, Morrow BR, Wells M, Tipton DA, Garcia-Godoy F. Microleakage of cements in prefabricated zirconia crowns. Pediatr Dent 2018;40:136–9.
[9] Montaser A, Gabal Z, Bayoumi RE. Influence of vertical versus horizontal margin configuration on fracture resistance of zirconia copings restorations with varied occlusal thickness. Egypt Dent J 2023;69:2073–81.
[10] Ali A, EL-Malt M, Mohamed EA. Comparative evaluation of equia forte microleakage versus resin-modified glass ionomer. Al-Azhar Dent J Girls 2019;6:249–54.
[11] Sayed EO, Mostafa El-Bolok AH. Effect of aging and nano silica surface treatment of zirconia ceramics crowns on microleakage. Egypt Dent J 2023;69:2203–11.
[12] Bahsi E, Sagmak S, Dayi B, Cellik O, Akkus Z. The evaluation of microleakage and fluoride release of different types of glass ionomer cements. Niger J Clin Pract 2019;22:961–70.
[13] Al-Haj Ali SN, Farah RI. In vitro comparison of microleakge between preformed metal crowns and aesthetic crowns of primary molars using different adhesive luting cements. Eur Arch Paediatr Dent 2018;19:387–92.
[14] Jain K, Katge F, Poojari M, Shetty S, Patil D, Ghadge S, et al. Comparative evaluation of microleakage of bioactive, ormocer, and conventional GIC restorative materials in primary molars: an in vitro study microleakage of three restorative materials. Int J Dent 2022;2022:11.
[15] Sahare P, Parvaze PA, Hiremath VR, Ramaiah VV, Shah SN, Melkundi M, et al. Assessment of microleakage and shear bond strength of conventional GIC, nanocomposite and RMGIC restorative materials. J Coast Life Med 2023;11:1353–6.
[16] Chakravarthy VS, Tamil S, Jayakumar S, Arumugam K, Monisha RJ, Ramasamy R, et al. An in vitro study to compare and evaluate microleakage and compressive strength of two different types of glass ionomer cements. J Res Adv Dent 2021;12:371–3.
[17] Singla T, Pandit IK, Srivastava N, Gugnani N, Gupta M. An evaluation of microleakage of various glass ionomer based restorative materials in deciduous and permanent teeth: an in vitro study. Saudi Dent J 2012;24:35–42.
[18] Sohrabi M, Ghadimi S, Seraj B. Comparison of microleakage of pedo jacket crowns and stainless steel crowns cemented with different cements. Front Dent 2019;16:31.
[19] Vohra F, Altwaim M, Alshuwaier AS, Alomayri A, Al Deeb M, AlFawaz YF, et al. Bond integrity and microleakage of dentin-bonded crowns cemented with bioactive cement in comparison to resin cements: in vitro study. J Appl Biomater Funct Mater 2020;3:416–21.