ORIGINAL RESEARCH

Comparison of Proximal Contact Tightness of Nano Zirconia Reinforced Glass Ionomer vs Conventional Nanohybrid Resin Composite: A Randomized Clinical Trial

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Abstract

Aim: To compare the proximal contact tightness of high translucency nano zirconia reinforced glass ionomer vs conventional nanohybrid resin composite when used in class II cavities in molars.

Materials and methods: Fifty-two participants with proximal carious lesions in their molars were involved in this trial. They were randomly allocated into two groups (n = 26). Group I (control group) received a nanohybrid composite (Tetric-N Ceram®, Ivoclar Vivadent™, Schaan, Liechtenstein), and group II (intervention group) received nano zirconia reinforced glass ionomer (Zirconomer Improved®, Shofu™, Kyoto, Japan). The proximal contact tightness of the restorations was assessed over 1 year at 3, 6, 9, and 12 months. Data was analyzed using MedCalc software, version 22 for Windows (MedCalc Software Ltd, Ostend, Belgium). Intergroup comparison was performed using the Chi-squared test with a statistical significance level set at ($p \leq 0.05$), and intragroup comparison within each intervention was done using Cochran's Q test with a statistical significance level set at ($p \leq 0.05$), followed by multiple comparisons.

Results: Intergroup comparison between both materials has shown no statistically significant difference between different follow-up periods: Baseline, 3, 6, 9, and 12 months ($p > 0.05$).

Conclusion: Nano zirconia reinforced glass ionomer is a good alternative for resin composite in achieving tight proximal contact in class II restorations, which is of high benefit in high caries risk patients due to its sustained fluoride protection, and also in difficult isolation situations due to its simple, easy, and fast bulk placement.

Trial registration: ClinicalTrials.gov, NCT06596707. Registered 11 September 2024—Retrospectively registered, https://clinicaltrials.gov/study/NCT06596707.

Keywords: Class II, Contact tightness, Glass ionomer, Occlusoproximal cavity, Resin composite, Zirconomer.

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Introduction

Dental caries has been thought for a long time to be a significant contributor to the burden of oral diseases worldwide. Dental practitioners need to select the right material based on the restorative situation. Numerous considerations should affect this choice, including multiple factors like the materials' physical properties, esthetics, biocompatibility, application, and patient caries risk level. Wilson and Kent[1] developed glass ionomer cements in the early 1970s as a restorative material. Chemical bonding to tooth structure, anticariogenic character, lack of exothermic polymerization, and satisfactory biocompatibility are the distinctive qualities of glass ionomer cements.[2]

Despite the benefits of GICs, their application as a restoration in stress-bearing areas is restricted due to their major drawbacks, mainly weak mechanical properties like low strength and toughness, and brittleness, which limit their use in areas with minimal load and in the restoration of anterior teeth.[1,3]

To address the limitations of earlier tooth-colored restorative materials, Shofu developed a modified glass ionomer known as zirconomer, a zirconia-reinforced glass ionomer. By adding zirconia fillers to the zirconomer glass component, the restoration's structural integrity is strengthened, and improved mechanical qualities are imparted to posterior load-bearing areas.[2]

Zirconomer, sometimes referred to as white amalgam, has the ability to withstand greater bending and compressive stresses and achieves less occlusal abrasion in conjunction with a rapid setting reaction. Zirconomer possesses the advantageous qualities of GIC and is just as strong as amalgam without containing mercury.[3] In addition to its superior mechanical properties, zirconomer can release and recharge fluoride, which may be advantageous for high caries risk people who are prone to dental cavities.[4]

Upon restoring proximal carious lesions, achieving an ideal contact area is crucial to avoid food retention and secondary caries. However, proximal restorations represent a challenge for clinicians, and tight contact is difficult to achieve, depending not only on the equipment and tools used, but also on restorative material type. Most contemporary tooth-colored restorative materials lack

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Table 1: Materials' specification, composition, and manufacturer

Material	*Specification*	*Composition*	*Manufacturer*
Tetric-N Ceram®	Light-cured nanohybrid resin composite	Dimethacrylates (19–20 wt.%), fillers (80–81 wt.%) including barium glass, ytterbium trifluoride, mixed oxide, and copolymers. Additives, initiators, stabilizers, and pigments as additional contents (<1 wt.%)	Ivoclar Vivadent™, Schaan, Liechtenstein
N-Etch	Etching gel	37% phosphoric acid with blue dye for a strong contrast to the tooth	Ivoclar Vivadent™, Schaan, Liechtenstein
Tetric-N Bond® Universal	Single-component, light-cured universal adhesive	Methacrylates, ethanol, water, highly dispersed silicon dioxide, initiators, and stabilizers	Ivoclar Vivadent™, Schaan, Liechtenstein
Zirconomer Improved®	High translucency nano zirconia reinforced glass ionomer	Powder: Fluoroaluminosilicate glass, zirconium oxide, pigments, and others. Liquid: Polyacrylic acid solution and tartaric acid	Shofu™, Kyoto, Japan

condensability and are associated with setting polymerization shrinkage.[5]

Since zirconia-reinforced glass ionomer was introduced, many trials have been carried out to assess its *in vitro* performance, such as compressive strength, microleakage, microhardness, antimicrobial effect, and ion release. However, *in vivo* clinical trials testing its clinical performance are very rare, and still, there is no study that assesses its clinical performance in achieving proximal contact tightness in posterior teeth.

Accordingly, this study aims to compare the proximal contact tightness of nano zirconia reinforced glass ionomer vs conventional nanohybrid resin composite when used in restoring class II cavities in molars.

The null hypothesis proposed is that both nano zirconia reinforced glass ionomer and conventional nanohybrid resin composite have the same clinical performance in achieving proximal contact tightness when used in restoring class II cavities in molars.

Materials and Methods

Study Settings

This study was carried out in the Department of Conservative Dentistry, Faculty of Dentistry, Cairo University, Egypt. All procedures were conducted in accordance with the ethical standards of the Research Ethics Committee of the Faculty of Dentistry, Cairo University (CREC), under Ethical Approval Number 27923. Written informed consent was obtained from all participants. The trial protocol was registered at ClinicalTrials.gov (Identifier: NCT06596707).[6]

Sample Size Calculation

The sample size was calculated depending on a previous study by Salem et al.[7] in 2022, in which optimum proximal contact in nanohybrid composites can be observed in 100% of cases. A two-tailed *Z* test for the difference between two independent proportions was used, with an alpha level of 5% and a power of 80%. The minimum required sample size was 23 teeth per group to detect a 30% difference. To account for potential dropouts, the sample size was increased by 10%, resulting in 26 teeth per group. Sample size calculation was performed using G*Power software (version 3.1.9.2 for Windows).

Materials

Materials used in this trial (Table 1) were nanohybrid composite (Tetric-N Ceram®, Ivoclar Vivadent™), N-Etch (Ivoclar Vivadent™), Tetric-N Bond® Universal (Ivoclar Vivadent™), and high translucency nano zirconia reinforced glass ionomer (Zirconomer Improved®, Shofu™).

Recruitment, Study Design, and Grouping

This study was designed as a randomized, controlled, prospective, double-blinded clinical trial with two parallel arms and a 1:1 allocation ratio. Participants were recruited from the outpatient clinics of the Department of Conservative Dentistry, Faculty of Dentistry, Cairo University, which serves a large and continuous population of eligible patients. Comprehensive personal, medical, and dental histories were obtained from all participants and recorded in their diagnostic charts. Written informed consent was obtained from each patient before trial initiation, in accordance with ethical requirements. A total of 52 patients were randomly allocated into two equal groups ($n = 26$). Group I (control) received a nanohybrid composite resin (Tetric-N Ceram®, Ivoclar Vivadent™), while group II (intervention) received a nano zirconia-reinforced glass ionomer (Zirconomer Improved®, Shofu™, Kyoto, Japan).

Eligibility Criteria

Eligible patients were enrolled according to predefined inclusion and exclusion criteria, summarized in Table 2, and the number of teeth in Table 3.

Randomization and Sequence Generation

The allocation sequence was generated using simple randomization by numbering participants from 1 to 52 with a random sequence generated by Random Sequence Generator (Randomness and Integrity Services Ltd., Random.org). Each number was randomly assigned to one of two groups: Group I (control; numbers 1–26) or group II (intervention; numbers 27–52). Allocation concealment was achieved using opaque, sealed envelopes containing the randomization codes, from which participants selected one envelope.

Blinding

This study was conducted as a double-blinded trial. Both the participants and the outcome assessors were blinded to the type of restoration applied. Blinding of the operator was not feasible due to differences in material manipulation and application procedures between the control and intervention groups.

Teeth Preparation and Matricing

After profound local anesthesia, the teeth were isolated using a rubber dam and suitable clamps. Conservative defect guided cavity

Table 2: Inclusion and exclusion criteria of the participants

Inclusion criteria	*Exclusion criteria*
1. Patients with occlusoproximal caries in molars classified as ICDAS III or IV	1. Pregnancy
2. 19–35 years	2. Disabilities
3. Males or females	3. Systemic disease or severe medical conditions
4. Co-operative patients agreeing to participate in the study	4. History of allergy to methacrylate
	5. Rampant caries
	6. Heavy smoking
	7. Xerostomia
	8. Lack of compliance
	9. Severe bruxism, clenching, or temporomandibular joint disorders

Table 3: Inclusion and exclusion criteria of teeth

Inclusion criteria	*Exclusion criteria*
1. Occluso-proximal caries in molars classified as ICDAS III or IV	1. Extensive carious lesions
2. Vital upper or lower molars without any signs of irreversible pulpitis	2. Periapical lesion or signs of pulpal inflammation
3. Intact contact with opposing teeth	3. Tooth hypersensitivity
4. Teeth with no previous restorations on any surface	4. Predictable prosthodontic restoration of teeth
	5. Heavy occlusion or heavy occlusal contacts
	6. Severe periodontal affection

preparation was done using a 245 pear-shaped carbide bur size 1 by Premier® mounted on a high-speed with air-water spray coolant. Suitable sectional ring Palodent® Plus by Dentsply™ was selected, in conjunction with a suitable sectional matrix of thickness 0.038 and wedges. The matrix system was applied to the prepared tooth.

Control Group

Regarding the control group, molars received nanohybrid composite (Tetric-N Ceram®, Ivoclar Vivadent™), and the material was applied according to the manufacturer's instructions. Selective enamel etching was done using 37% phosphoric acid gel (N-Etch, Ivoclar Vivadent™, Schaan, Liechtenstein). Acid etching was performed on the enamel for a duration of 20 seconds. Then, vigorous rinsing was done with air water spray for 20 seconds, and then dryness was achieved with water and oil-free compressed air until the etched enamel had a chalky white appearance.

Tetric N-Bond® Universal was applied to the prepared cavity, enamel, and then dentin, respectively. The adhesive was rubbed into the cavity preparation for 20 seconds using the brush applicator. Air-thinning of the adhesive with water and oil-free compressed air was done until an immobile glossy adhesive layer was evident. Preventing any contamination of the cavity preparation with saliva, water, blood, or gingival sulcular fluid is mandatory during application. In the case of contamination, the cavity must be rinsed again, and the procedures must be repeated. Tetric N-Bond Universal was light-cured for 10 seconds using a 3M™ Elipar™ DeepCure-S LED curing unit at an intensity of 1,470 mW/cm^2 (±10–20%).

Nanohybrid composite Tetric-N Ceram® was applied by centripetal technique to restore the absent proximal wall first by building an eggshell layer from the periphery towards the center of the cavity. Then, the rest of the cavity was completed afterwards incrementally using the oblique packing technique. Each increment should not exceed 1 mm and should not join more than two surfaces of cavity preparation. Each increment was cured for 20 seconds using 3M™ Elipar™ Deep Cure-S LED with curing intensity of 1,470 mW/cm^2 (–10%/+20%). After curing the last increment, glycerin was used to cover the restoration, and the restoration was cured for another curing cycle to ensure optimum curing of the surface layer without the formation of oxygen inhibited layer. Occlusion was evaluated using 40-µm articulating paper (Arti-Check® Micro-Thin, Bausch™). Then, finishing the restoration was done using red and yellow coded diamond abrasives by Kulzer™. Finally, polishing of restoration was done using a two-step polishing system by EVE, DIACOMP® PLUS.

Intervention Group

For the intervention group, molars received restorations with nano zirconia–reinforced glass ionomer (Zirconomer Improved®, SHOFU™), following the application protocol recommended by the manufacturer. Zirconomer was dispensed by the ratio recommended by the manufacturer; powder/liquid ratio 3.6/1.0 (2 scoops: 1 drop). The powder was divided into two equal portions; the first portion was added to the dispensed liquid and mixed for 5–10 seconds with a spatula. Then, the other half was added and mixed until it had a thick putty-like consistency. Mixing must be finished within only 30 seconds, something that needs a well-trained and skillful operator. The mix was packed into the cavity and shaped to the desired form. Seven minutes after placement, the restorations were finished using Super-Snap® abrasive discs (SHOFU™) and stones (Kulzur™). Cocoa butter (petroleum jelly) was applied as a lubricant during finishing to prevent heat generation and desiccation. Following finishing, the restoration surfaces were coated with cocoa butter to protect them from moisture.

Outcome Assessment

Two calibrated assessors, blinded to group allocation, performed the evaluation of the restorations. All participants were assessed at 3, 6, 9, and 12 months. The clinical evaluation criteria were related to the proximal contact tightness, according to Modified USPHS

Table 4: Frequency and percentage for proximal contact scores for the intergroup comparison between materials within each follow-up and intragroup comparison within each material between different follow-up periods

	Zirconomer			*Nanohybrid composite*			
Follow-up	*A*	*B*	*C*	*A*	*B*	*C*	*p-value*
Baseline	26 (100%)	0 (0%)	0 (0%)	26 (100%)	0 (0%)	0 (0%)	$p = 1.0000$
3 months	26 (100%)	0 (0%)	0 (0%)	26 (100%)	0 (0%)	0 (0%)	$p = 1.0000$
6 months	22 (91.7%)	2 (8.3%)	0 (0%)	23 (95.8%)	1 (4.2%)	0 (0%)	$p = 0.5552$
9 months	22 (91.7%)	2 (8.3%)	0 (0%)	23 (95.8%)	1 (4.2%)	0 (0%)	$p = 0.5552$
12 months	19 (79.2%)	5 (20.8%)	0 (0%)	21 (87.5%)	3 (12.5%)	0 (0%)	$p = 0.4434$
p-value		$p < 0.001$*			$p = 0.006$*		

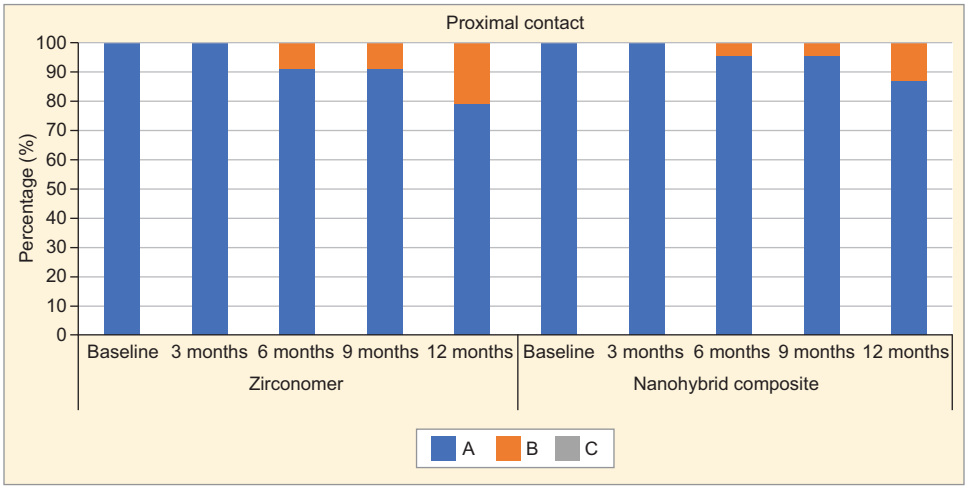


Fig. 1: Bar chart showing the percentage of proximal contact scores within each material at different follow-up periods

criteria, by using a dental floss, and were scored according to the following criteria:[6]

- Alpha (A): Normal proximal contact, floss can be passed with resistance met upon its passing.
- Bravo (B): Moderate proximal contact, without damage to tooth, gingiva, or periodontal tissues. Floss can be passed without resistance, but still, there is contact.
- Charlie (C): No proximal contact with adjacent tooth, with evident damage to tooth, gingiva, or periodontal tissues.

Statistical Analysis

Data were analyzed using MedCalc software, version 22 for Windows (MedCalc Software Ltd., Ostend, Belgium). Categorical variables were presented as frequencies and percentages. Intergroup comparisons between the two interventions were performed using the Chi-squared test, with statistical significance set at $p \leq 0.05$. Intragroup comparisons within each intervention were conducted using Cochran's *Q* test, followed by multiple comparisons, with significance also set at ($p \leq 0.05$) followed by multiple comparisons. Relative risk was calculated to assess clinical significance. All tests were two-tailed, with a 95% confidence interval and 80% power.

Results

Proximal Contact

Intergroup comparisons across all follow-up periods revealed no statistically significant differences between the two groups at baseline, 3, 6, 9, and 12 months ($p > 0.05$). Intragroup comparison within zirconomer has shown a statistically significant change in proximal contact tightness with time ($p < 0.001$). Intragroup comparison within the nanohybrid composite has shown statistically significant change in proximal contact tightness with time ($p = 0.006$) (Table 4 and Fig. 1). There was 1.6 times more risk of proximal contact (score B) of zirconomer when compared to nanohybrid composite after 12 months [RR = 1.66 (95% 0.4475–6.2067; $p = 0.4464$)].

Demographic Data

This study included 52 teeth with proximal carious lesions, which were randomly allocated to the intervention and control groups ($n = 26$ each). After 12 months, 48 teeth were evaluated, corresponding to a retention rate of 92%. The distribution of teeth is presented in Table 5, with no statistically significant difference between the groups in terms of tooth distribution ($p = 0.8490$).

Discussion

Establishing proper proximal contacts is essential in proximal restorations. Tight anatomical proximal contacts can prevent food impaction and tooth cavitation.[8] Moreover, tight and well-contoured proximal contact prevents teeth migration and aids in maintaining dental arch integrity, periodontal health, and so a well-functioning dentition.[9,10]

This trial assessed the clinical performance of the introduced high-translucency nano-zirconia-reinforced glass ionomer (zirconomer improved) in achieving tight proximal contact when

Table 5: Teeth distribution among groups

	Tooth									
Group	*16*	*17*	*26*	*27*	*36*	*37*	*38*	*46*	*47*	*Row total (RT)*
Zirconomer	4 15.4% RT 44.4% CT	4 15.4% RT 44.4% CT	3 11.5% RT 75.0% CT	3 11.5% RT 75.0% CT	4 15.4% RT 50.0% CT	2 7.7% RT 33.3% CT	1 3.8% RT 100.0% CT	3 11.5% RT 50.0% CT	2 7.7% RT 40.0% CT	26 (50.0%)
Nanohybrid composite	5 19.2% RT 55.6% CT	5 19.2% RT 55.6% CT	1 3.8% RT 25.0% CT	1 3.8% RT 25.0% CT	4 15.4% RT 50.0% CT	4 15.4% RT 66.7% CT	0 0.0% RT 0.0% CT	3 11.5% RT 50.0% CT	3 11.5% RT 60.0% CT	26 (50.0%)
Column total (CT)	9 (17.3%)	9 (17.3%)	4 (7.7%)	4 (7.7%)	8 (15.4%)	6 (11.5%)	1 (1.9%)	6 (11.5%)	5 (9.6%)	52

restoring class II cavities in molars. Zirconomer improved (the updated version of zirconomer) is a novel restorative material manufactured from ceramic and zirconia-reinforced glass ionomer. It consists of zirconium oxide, glass powder, polyacrylic acid (20–50%), tartaric acid (1–10%), and deionized water as the liquid component. Zirconomer is formed by a precise manufacturing technique that offers an equivalent strength to amalgam. The glass phase undergoes finely controlled micronization to get the proper filler size and properties. The primary powder component of zirconomer is zirconium oxide derived from baddeleyite (ZrO_2), containing a high zirconia content of 96.5–98.5%.[11]

The uniform incorporation of nano-sized zirconia particles enhanced the material's durability, strength, and occlusal load tolerance. Moreover, it has transformational toughening property, which gives zirconia the ability to prevent the cracks' propagation and subsequently its special high mechanical properties.[1] In addition, nano zirconia particles enhance the handling characteristics and esthetic properties by providing enough translucency to match tooth color. Accordingly, zirconomer Improved is considered a durable and reliable self-adhesive tooth-colored bulk-fill posterior restoration.[11]

Nanohybrid resin composite was chosen as the comparator material because it is the most used versatile restorative material in dental practice. It is also the first choice for restoring posterior teeth, due to the multiple restorative improvements that resulted in reliable clinical results, in addition to excellent esthetics.[12,13] Moreover, there are several RCTs tested the nanohybrid composite performance in the posterior region, and they were capable of achieving satisfactory clinical results.[14]

Standardization of the used sectional matrix system was done (Palodent® Plus, Dentsply™) to avoid any confounding factor while comparing the two tested materials. Using a sectional matrix with separating rings is considered the gold standard for restoring class II cavities due to the achievement of strong and tight proximal contact areas.[10]

The results of this trial revealed that there is no statistically significant difference between nano zirconia reinforced glass ionomer and nanohybrid composite within different follow-up periods: Baseline, 3, 6, 9, and 12 months, which means that the null hypothesis is accepted and that nano zirconia reinforced glass ionomer can be a good alternative for resin composite in class II restoration. This will be of high benefit in cases with difficult isolation, as zirconomer can provide low technique sensitivity. This is mainly due to its chemical bonding to the tooth structure, working under humid conditions, and short working time.[15]

The combination of such chemical adhesion with the high strength, durability, and sustained fluoride release makes it a perfect choice as a permanent posterior restoration in high caries risk patients, in addition to cases that require strong structural cores and bases.[16]

To date, there are very limited data available in the literature testing the clinical performance of zirconia-reinforced glass ionomer,[15] except for a study by Gupta et al.[17] who assessed the postoperative sensitivity after zirconomer application in cervical non-carious lesions and two other studies by Bayazıt et al.[18] and Abdou et al.[15] who assessed its clinical performance in class I cavities. Accordingly, to date and to our knowledge, this is the first trial to assess zirconomer clinical performance in restoring class II, and there is no information in the literature about its proximal contact tightness achievement.

However, we can find in the literature some trials that supported the idea of zirconomer use in the posterior region, as was done in this trial. As reported by Bhatia et al.[1] who mentioned that zirconia-reinforced glass ionomer is a promising restorative material for stress-bearing areas owing to its superior mechanical properties, low water sorption, and minimal solubility. Additionally, it may serve as an esthetic alternative to silver-reinforced glass ionomer cements.

Moreover, Chalissery et al.[16] found that zirconia-reinforced glass ionomer can be used in stress-bearing areas because the addition of zirconia fillers in the zirconomer glass phase enhances its mechanical properties by reinforcing the structural integrity of the restoration and making it eligible to be used as a posterior restoration.

In addition, Abdou et al.[15] assessed the clinical performance of zirconia reinforced glass ionomer in class I cases and found no failures during 12 months follow-up period. They mentioned that the improvements that happened in the last few years in glass ionomer would expand their use by giving reliable performance in variable conditions and enhancing the patients' quality of life. They added that the addition of nano zirconia fillers to glass ionomer ensures enhanced mechanical properties for the sake of use in stress-bearing areas and improves its esthetics.

On the other side, the intra-group comparison within both group have shown little changes in proximal contact tightness with time, recorded as bravo score. Those few patients with a Bravo score can be explained by minimal variations during the clinical application procedure, especially with the absence of the powerful condensability of both materials.[19] Moreover, some patients revealed gingival problems through the 12 months follow-up period and suffered from open gingival embrasures that contributed to food impaction, adversely affecting the periodontium health, which subsequently affected the interproximal contact tightness.[20]

The limitation of this trial is the lack of prior clinical trials on this topic and the need for longer-term follow-up periods to ensure the results of this study.

Conclusion

Nano zirconia reinforced glass ionomer is a good alternative for resin composite in achieving tight proximal contact in class II restorations, which is of high benefit in high caries risk patients due to its sustained fluoride protection, and also in difficult isolation situations due to its simple, easy, and fast bulk placement.

Recommendations

As there is very limited data available in the literature about the clinical performance of nano zirconia reinforced glass ionomer restorations, more clinical trials with longer follow-up periods are recommended.

Ethical Approval

This study protocol was approved by the research ethics committee of the Faculty of Dentistry, Cairo University, on 26-9-2023, Approval Number: 27923.

Declaration of Originality

This manuscript is original and has not been published previously or submitted to any other journal, institution, or body for consideration.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Artificial Intelligence (AI) Disclosure

No AI-assisted technologies were used.

Authors' Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by the authors.

References

1. Bhatia HP, Singh S, Sood S, et al. A comparative evaluation of sorption, solubility, and compressive strength of three different glass ionomer cements in artificial saliva: An in vitro study. Int J Clin Pediatr Dent 2017;10(1):49. DOI: 10.5005/jp-journals-10005-1407.
2. Kumari A, Singh N. A comparative evaluation of microleakage and dentin shear bond strength of three restorative materials. Biomater Investig Dent 2022;9(1):1–9. DOI: 10.1080/26415275.2022.2033623.
3. Karakaş SN, Küden C. AFM and SEM/EDS characterization of surfaces of fluorine-releasing bulk-fill restorative materials aged in common liquids. J Oral Sci 2022;64(3):202–207. DOI: 10.2334/josnusd.22-0020.
4. Surabhilakshan SL, Gopinath AS, Joseph S, et al. Comparative evaluation of fluoride release and recharge of zirconia-reinforced, resin-modified, and conventional glass ionomer cements. World 2021;12(6):470. DOI: 10.4103/JCD.JCD_222_20.
5. Cerdán F, Ceballos L, Fuentes MV. Quality of approximal surfaces of posterior restorations in primary molars. J Oral Sci 2021;63(4):347–351. DOI: 10.2334/josnusd.21-0264.
6. Alaki SM, Abdulhadi BS, AbdElBaki MA, et al. Comparing zirconia to anterior strip crowns in primary anterior teeth in children: A randomized clinical trial. BMC Oral Health 2020;20:1–11. DOI: 10.1186/s12903-020-01305-1.
7. Salem MN, Hassanein OE, El Kassas DW, et al. 12-months clinical evaluation of fiber reinforced bulk fill resin composite versus incremental packing of nanohybrid resin composite in restoration of deep proximal lesions of permanent molars: A randomized controlled trial. Acta Stomatol Croat 2022;56(3):267–280. DOI: 10.15644/asc56/3/5.
8. Abbassy KM, Elmahy WA, Holiel AA. Evaluation of the proximal contact tightness in class II resin composite restorations using different contact forming instruments: A 1-year randomized controlled clinical trial. BMC Oral Health 2023;23(1):729. DOI: 10.1186/s12903-023-03462-5.
9. Loomans BAC, Opdam NJM, Roeters FJM, et al. The long-term effect of a composite resin restoration on proximal contact tightness. J Dent 2007;35(2):104–108. DOI: 10.1016/j.jdent.2006.05.004.
10. Tolba ZO, Oraby E, Abd El Aziz PM. Impact of matrix systems on proximal contact tightness and surface geometry in class II direct composite restoration in-vitro. BMC Oral Health 2023;23(1):535. DOI: 10.1186/s12903-023-03222-5.
11. Paul S, Raina A, Kour S, et al. Comparative evaluation of fluoride release and re-release and recharge potential of zirconomer improved and cention. J Conserv Dent 2020;23(4):402–406. DOI: 10.4103/JCD.JCD_222_20.
12. Pizzolotto L, Moraes RR. Resin composites in posterior teeth: Clinical performance and direct restorative techniques. Dent J 2022;10(12):222. DOI: 10.3390/dj10120222.
13. Paolone G, Diana C, Cantatore G. 2023 state-of-the-art in resin-based composites and future trends. Compend Contin Educ Dent 2023;44(2):98–100. PMID: 36802751.
14. Angerame D, De Biasi M. Do nanofilled/nanohybrid composites allow for better clinical performance of direct restorations than traditional microhybrid composites? A systematic review. Oper Dent 2018;43(4):E191–E209. DOI: 10.2341/17-212-L.
15. Abdou D, Akah M, Mosallam RS, et al. Clinical performance of zirconia reinforced versus conventional viscous glass ionomer in class I cavities of geriatric patients: A 1-year randomized controlled clinical trial. Contemp Clin Dent 2024;15(2):98–104. DOI: 10.4103/ccd.ccd_440_23.
16. Chalissery VP, Marwah N, Almuhaiza M, et al. Study of the mechanical properties of the novel zirconia-reinforced glass ionomer cement. J Contemp Dent Pract 2016;17(5):394–398. DOI: 10.5005/jp-journals-10024-1861.
17. Gupta R, Patel A, Nikhade P, et al. Comparative evaluation of postoperative sensitivity using three different tooth-colored restorative materials in non-carious cervical lesions: A split-mouth design in vivo study. Cureus 2022;14(8):e27861. DOI: 10.7759/cureus.27861.
18. Bayazıt EÖ, Başeren M, Meral E. Clinical comparison of different glass ionomer-based restoratives and a bulk-fill resin composite in class I cavities: A 48-month randomized split-mouth controlled trial. J Dent 2023;131:104473. DOI: 10.1016/j.jdent.2023.104473.
19. Anantula K, Vankayala B, Yadav SS. Proximal contact tightness of direct Class II composite resin restorations with various matrix systems: A systematic review. J Conserv Dent Endod 2024;27(1):11–16. DOI: 10.4103/JCDE.JCDE_203_23.
20. Kolte AP, Kolte RA, Bawankar P. Proximal contact areas of maxillary anterior teeth and their influence on interdental papilla. Saudi Dent J 2018;30(4):324–329. DOI: 10.1016/j.sdentj.2018.05.007.