ORIGINAL ARTICLE

CLINICAL MANAGEMENT OF MARGINAL DEFECTS IN ADHESIVE RESTORATIONS

Alexandru-Dan Popescu[1,†], Mihaela Jana Ţuculină[1,†], Bianca Molea[2], Jaqueline Popescu[3,*], Adelina Smaranda Bugălă[1], Ana-Maria Rîcă[1], Adela Nicoleta Staicu[1], Anca Gheorghe[1], Carina Bănică[1], Lelia Mihaela Gheorghiță[1], Alice Petrache[1] and Oana Andreea Diaconu[1]

[1] Department of Endodontics, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
[2] Private Dental Practice, Craiova, Romania
[3] Department of Pediatrics, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania

All authors contributed equally to this work.

[*] Corresponding author:
Jaqueline Popescu,
Department of Pediatrics, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
Email: jaqueline.popescu@umfcv.ro

Abstract: *Background*: Dental caries is a dynamic and continuous process resulting from cycles of demineralization and remineralization of dental hard tissues, with the balance between these cycles determining the disease stage. The aim of this study was to analyze the clinical success of direct light-cured composite restorations in posterior teeth; *Methods*: The study focused on marginal adaptation quality, preservation of occlusal morphology, and restoration survival according to their extent and location. A clinical-statistical study was conducted between March and December 2024 on a sample of 86 patients aged 18–62 years who attended a private dental office in Craiova, with all participants providing informed consent; *Results*: Statistically significant differences were found between types of restorations requiring repair, with certain types of repairs occurring more frequently than others. Specifically, restorations in teeth affected by abrasion and secondary caries were significantly more common than those involving tooth fracture or erosion. Secondary caries and restoration fracture were the only categories reaching individual statistical significance (p=0.048), however, overall distribution did not differ significantly from a random pattern (p=0.386); *Conclusions*: Repairs were more frequently necessary in cases involving dental abrasion and secondary caries, while tooth fracture and erosion cases were less common.

Keywords: marginal adaptation, direct composite restorations, secondary caries, dental abrasion

 DOI: 10.58179/RJDR2401

1. Introduction

Dental caries is a dynamic and continuous process resulting from cycles of demineralization of the hard dental tissue, followed by cycles of remineralization. The balance between these two cycles determines the stage of the disease [1]. There is a close relationship between oral health and quality of life, just as it has been shown that socioeconomic status and the environment of origin have an impact on people's oral health [2].

Despite major achievements in oral health worldwide, caries remains a serious problem, especially among underprivileged groups in low, middle, and high-income countries, affecting 60% to 90% of schoolchildren and the vast majority of adults. It is also the most widespread oral health problem in several Asian and Latin American countries [3].

Amalgam has been the traditional material for filling cavities in posterior teeth for the past 100 years due to its long-term effectiveness and lower cost. Amalgam is still used as a restorative material in certain parts of the world. However, in recent years there have been concerns regarding the use of amalgam restorations, related to the release of toxic mercury into the body and its environmental impact as a result of its disposal into the atmosphere [4,5].

Composites have gradually become an aesthetic alternative to amalgam restorations, and there have been remarkable improvements in their mechanical properties to withstand the masticatory forces of posterior teeth [4,5].

Studies conducted in the last 10 years have provided numerous pieces of evidence regarding the low quality of composites, suggesting higher failure rates and the risk of secondary caries compared to amalgam restorations. Despite the benefits of amalgam, especially in the restoration of posterior teeth with proximal caries, it is unlikely that new research will change the opinion regarding its safety [4].

Other studies have suggested that the restorative material influences the survival rate of primary posterior restorations, with composite showing the best performance [6].

The longevity of direct posterior composite restorations is well established for permanent teeth. Cavity size, salivary infiltration, and occlusal imbalances are factors that significantly affect survival, especially in composite restorations. In addition to composites, another direct restorative material for posterior teeth aesthetics is resin-modified glass ionomer cement (RMGIC) and conventional glass ionomer cement (GIC) [7,8].

The results of many studies indicate that adhesive materials can be one of the therapeutic options for moderate to large two-surface Class II restorations in posterior teeth [9].

However, multi-surface composite restorations in posterior teeth require longer treatment time and precise technical skills. GIC cements are less technique-sensitive but are relatively fragile due to their lower flexural strength and wear resistance [10,11].

To increase the hardness and wear resistance of conventional GICs, improvements have been made to their consistency with the introduction of high-viscosity GICs. Furthermore, the application of a nanofilled varnish has been proposed to

 DOI: 10.58179/RJDR2401

protect these materials, covering surface pores and thus improving the mechanical properties of the restorative material [12].

Minimally invasive therapy allows the use of more conservative restorative techniques, limiting cavity preparation mainly to the removal of necrotic tissue while preserving the intact healthy structure of the teeth [13].

Some patients may still undergo more invasive treatment despite the availability of effective evidence-based minimally invasive options. Dentists recognize the importance of continuous education and ongoing improvement of methods for treating dental caries [14].

The aim of this study was to analyze the clinical success of direct light-cured composite resin restorations in posterior teeth. The study focuses on the quality of marginal adaptation of the restorations, as well as the preservation of the occlusal surface morphology, and their survival, depending on their extent and location.

2. Materials and method

The studies were carried out according to the approval no. 412/04.11.2025 issued by the Ethics and Scientific Deontology Committee of the University of Medicine and Pharmacy of Craiova.

The clinical-statistical study was conducted between March and December 2024 on a sample of 86 patients, aged between 18 and 62 years, who attended a private dental clinic in Craiova. All patients provided informed consent regarding their participation in the study.

Furthermore, patients were required to be cooperative, willing to participate in the study, and able to attend periodic follow-up appointments. Patient data were collected from direct clinical examinations and patient records.

The variables evaluated included patient age and gender, tooth type, extent and location of restorations, quality and longevity of direct restorations, restorative materials used, harmful habits, parafunctional activities, secondary caries, and maintenance therapy.

Restorations performed with composite materials by a single operator were examined and evaluated. To be included in the study, restorations had to have been functional in the oral cavity for at least three years and performed by the attending dentist so that the restorative material used was known. Only restorations on teeth with an occluding antagonist and adjacent teeth were included in the study. Occlusal relationships had to be favorable and stable for the teeth included in the study.

All patients had complete dental arches. Patients with removable prostheses or extensive edentulism were excluded. Additional exclusion criteria included a history of drug abuse, medication dependency, or alcohol abuse; unavailability for periodic follow-up; severe bruxism; periodontally compromised teeth; endodontically treated teeth; and patients with unstable medical or physiological conditions.

After applying the exclusion criteria, a total of 380 direct restorations made of light-cured composite resin in posterior teeth were included in the study.

Data were collected in Microsoft Excel and statistically processed.

The restorative materials used in the clinic were:

- Nanohybrid composites (Tetric EvoCeram, Ivoclar Vivadent, Schaan,

 DOI: 10.58179/RJDR2401

Liechtenstein and Filtek Z250; 3M ESPE);
- Nanocomposites (Universal Filtek Supreme XT; 3M ESPE).

The clinical protocol followed over the years included the following steps:

- All dental surfaces were cleaned to remove dental plaque and the salivary pellicle using a prophylactic paste without fluoride (Cleanic, Kerr, Orange, CA, USA) and a dental brush, using conventional rotational speeds.
- Depending on the prepared cavity, anesthesia was administered.
- Teeth were isolated using cotton rolls and a rubber dam system.
- Cavities were prepared using diamond/extradure burs in spherical, pear-shaped, and cylindrical forms (Komet, Lemgo, Germany) with water cooling (Figure1).
- Cavity preparation was performed until the cavity margins were confirmed to be located in sound enamel and the cavity walls in sound dentin.
- Class II cavities were restored using a pre-contoured sectional matrix system (Palodent Plus, Dentsply, York, PA, USA).
- Enamel was selectively etched with 37% phosphoric acid (Figure 2), and a two-step adhesive (Adper Single Bond, 3M ESPE) (Figure 3) was applied to both enamel and dentin according to the manufacturer's instructions and light-cured for 20 seconds.

Figure 1. Diamond and super-hard burs used for cavity preparation.

Figure 2. 37% phosphoric acid used for demineralizing the cavity walls.

DOI: 10.58179/RJDR2401

Figure 3. Dentin adhesive Adper Single Bond (3M ESPE).

- The restorative materials were placed in layers no thicker than 2 mm.
- The restorative materials were light-cured for 20 seconds using an LED curing light (D-Light; GC) with an intensity of 1200 mW/cm² (Figure 4).
- Occlusal contact was checked using colored articulating paper.
- Restorations were finished with fine and extra-fine flame-shaped diamond burs (H135F.314.014 and 368LEF.314.016, Komet) for gross finishing, while fine finishing was performed using carbide burs (H48LF.314.012, Komet).
- Cervical adaptation and proximal contact were checked with dental floss and finished as needed using flexible discs (System Compo, Komet).
- Restorations were then polished with polishing points (9523uf.204.030, Komet) and diamond-particle polishing paste (Gradia Diapolisher, GC).

Figure 4. LED light-curing unit.

- Occlusal contact was checked using colored articulating paper.
- Restorations were finished with fine and extra-fine flame-shaped diamond burs (H135F.314.014 and 368LEF.314.016, Komet) for gross finishing, while fine finishing was performed using carbide burs (H48LF.314.012, Komet).
- Cervical adaptation and proximal contact were checked with dental floss and finished as needed using flexible discs (System Compo, Komet).
- Restorations were then polished with polishing points (9523uf.204.030, Komet) and diamond-particle polishing paste (Gradia Diapolisher, GC).

Restoration Evaluation

The evaluators consisted of two experienced clinicians and an observing student, who were trained to assess restorations using the FDI criteria. After individual calibration on the web-calib platform, the evaluators assessed a set of 16

 DOI: 10.58179/RJDR2401

restoration images, assigning scores to each. The evaluation results showed excellent inter-rater agreement, with average values ranging between 0.939 and 0.989 for the following variables: surface staining, marginal discoloration, overall functional properties, restoration fracture, and marginal adaptation and retention of restorations.

The criteria used for evaluations included aesthetic aspects (marginal appearance and surface staining), functional characteristics (all criteria except occlusion and wear), and biological considerations (all available criteria).

The primary outcomes were expressed as the survival rate and success rate of restorations. Survival was defined as a restoration that does not require replacement (FDI-2 scores of 1-4), while success was defined as a restoration not requiring replacement or repair (FDI-2 scores of 1-3).

Failure criteria included: fracture of the tooth and/or restoration, presence of secondary caries, presence of postoperative sensitivity, presence of wear lesions (erosion, abfraction, and abrasion), endodontic treatment, or tooth extraction.

The obtained data were statistically analyzed using the chi-square test of independence, calculating the p-value, with significance defined as $p > 0.05$.

3. Results

The study included 86 patients, of whom 48 were women and 38 were men, the patients' ages ranged from 18 to 62 years. For this study sample, a total of 324 adhesive restorations were selected on maxillary and mandibular molars (Table 1).

A chi-square test was performed to assess the association between patients' gender and the type of dental restorations. Since $p= 0.727$ is much greater than the significance threshold of 0.05, it was concluded that there is no statistically significant association between patients' gender and the type of restorations. These restorations were periodically evaluated, and it was found that some were still properly adapted, others required replacement, and some restorations were only repaired (Table 2).

Table 1. Distribution of patients by gender and type of fillings.

Gender	Type of fillings			p (Chi-Square test)
	Class I	Class II	Class III	
F	98	76	20	0.727
M	68	52	10	

Table 2. Distribution of fillings that need to be restored or repaired according to the gender of the patients.

Gender	Correctly fitted fillings	Fillings that required repair	Fillings that need to be redone	p (Chi-Square test)
F	120	54	20	0.026
M	85	22	23	
p	0.597	**0.032**	0.080	

 DOI: 10.58179/RJDR2401

The p-value (0.026) is less than 0.05, which means there is a statistically significant difference in the distribution of restoration types between females and males. Thus, it can be stated that the patient's gender significantly influences the outcome of the dental restoration, whether it is a proper adaptation, requires repair, or complete replacement.

Regarding properly adapted restorations, there is no statistically significant difference between females and males in terms of the number of correctly adapted restorations. The distribution is similar for both genders. For restorations that require repair, a statistically significant difference between genders was observed. Females had a significantly higher number of restorations that required repair compared to males. Considering restorations that need to be replaced, the result is close to statistical significance but does not reach the standard threshold of 0.05. There is a suggested tendency for males to require replacement more often, but the difference is not statistically significant.

The repair of restorations was performed in the following situations (Table 3):

- secondary caries;
- restoration fracture;
- tooth fracture;
- teeth with erosion;
- teeth with abrasion;
- adjustment of the anatomical contour.

Table 3. Distribution of fillings that need to be repaired according to the causal factor.

Compromised fillings		**77**
Type of repair	secondary caries	20
	restoration fracture	18
	tooth fracture	3
	teeth with erosion	4
	teeth with abrasion	21
	adjustment of the anatomical contour	11

Table 4. Distribution of fillings that need to be repaired according to the causal factor.

Compromised fillings		**77**
The type of filling that needs to be restored	secondary caries	12
	restoration fracture	12
	tooth fracture	4
	teeth with erosion	6
	teeth with abfraction	3
	postoperative sensitivity	6

The differences between the types of restorations requiring repair are statistically significant. In other words, certain types of repairs occur significantly more often than others. For example, "teeth with abrasion" and "secondary caries" are much more frequent

 DOI: 10.58179/RJDR2401

than "tooth fracture" or "teeth with erosion." The replacement of restorations was performed in the following situations (Table 4):

- postoperative sensitivity;
- secondary caries;
- restoration fracture;
- tooth fracture;
- teeth with erosion;
- teeth with abfraction

Secondary caries and restoration fractures are the only categories that reach individual statistical significance (p = 0.048). However, overall, the distribution is not significantly different from a random one (p = 0.386). It cannot be stated that a certain type of compromised restoration predominates significantly over the others, the differences appear to be random.

At the time of examination, 43 restorations (13.27%) were functional, and 205 restorations (63.27%) were considered clinically successful. Seventy-seven restorations (23.76%) failed.

The therapeutic approach for managing localized dentin sensitivity emphasizes identifying contributing factors and evaluating the condition of existing restorations to determine an appropriate, minimally invasive intervention. In situations where tooth 3.7 exhibits short-duration sensitivity to cold and sweet stimuli, clinical examination may reveal an occluso-mesial physiognomic restoration showing occlusal abrasion, along with secondary carious involvement at the gingival margin of the vertical component (Figure 5).

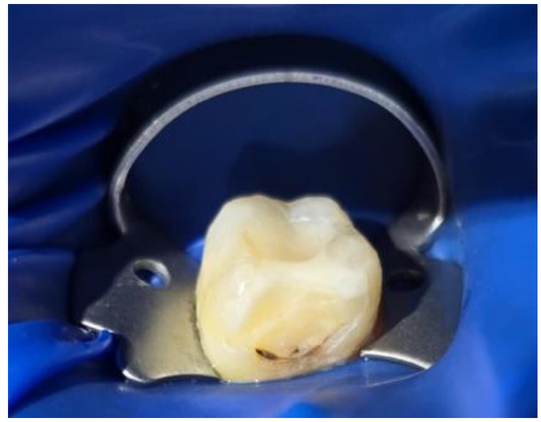

Figure 5. Initial appearance of the occlusal-mesial filling.

A decision was made to partially remove the restoration, reshaping the marginal contour for better adaptation and to prevent marginal microleakage (Figure 6).

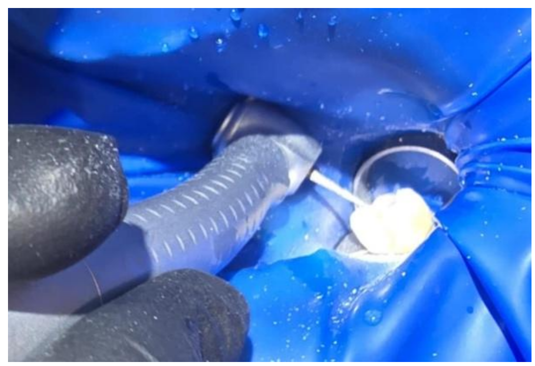

Figure 6. Preparing the new cavity design.

After cavity cleaning, a demineralizing gel was placed in the cavity (Figure 7).

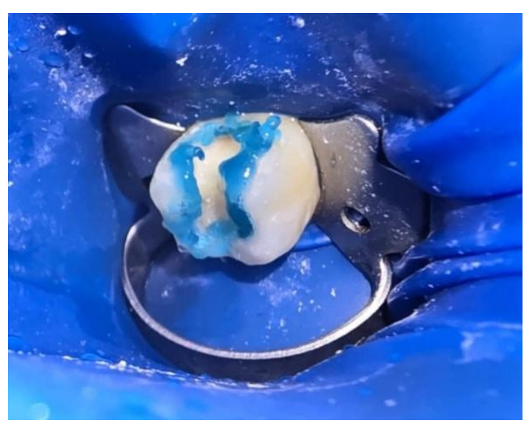

Figure 7. Applying demineralizing gel.

 DOI: 10.58179/RJDR2401

The demineralizing gel was rinsed off and the cavity was dried. A dentin adhesive was applied (Figure 8) and light-cured (Figure 9).

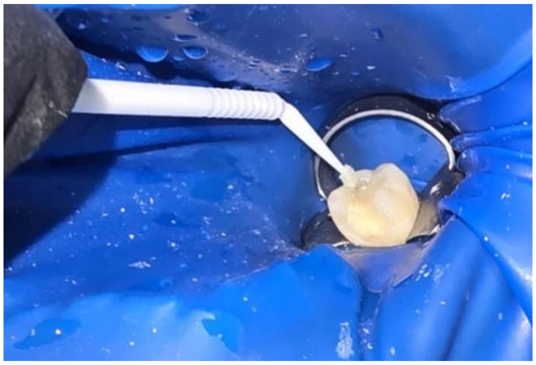

Figure 8. Applying the adhesive system.

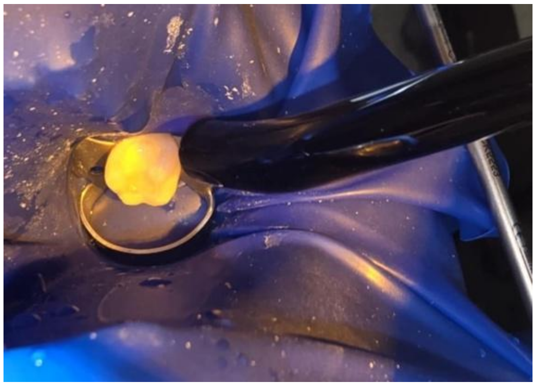

Figure 9. Light curing of the adhesive system.

The restorative material was shaped and light-cured. Excess material was removed, and the restoration was finished and polished (Figure 10).

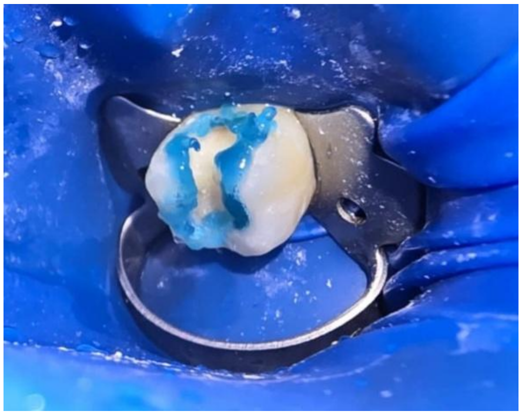

Figure 10. Final appearance of the occlusal-mesial restoration.

During routine clinical evaluations, the assessment of molar 4.6 may reveal a vestibular pit restoration with signs of marginal microleakage. Additional findings can include the presence of an occlusal carious lesion accompanied by pronounced abrasion on the occlusal surface of the tooth (Figure 11).

The restoration and altered hard dentin were removed, and a Class IB cavity was prepared (Figure 12).

Figure 11. Applying the adhesive system.

Figure 12. Light curing of the adhesive system.

Altered tissue was also removed from the occlusal surface, creating a Class IA cavity (Figure 13).

A demineralizing gel was applied to the enamel, and after 20 seconds the dental surfaces were rinsed and dried (Figure 14). The dentin adhesive was applied with a brush, light-cured, and layers of composite material were placed (Figure 15).

Figure 13. Applying the adhesive system.

Figure 14. Light curing of the adhesive system.

Figure 15. Light curing of the adhesive system.

The restorations were finished, occlusion was checked (Figure 16), and then polished (Figure 17).

Figure 16. Applying the adhesive system.

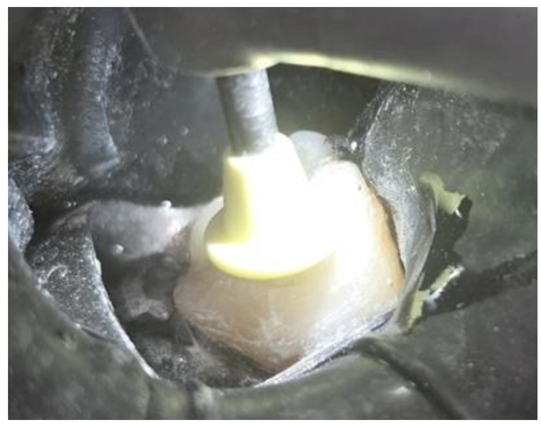

Figure 17. Light curing of the adhesive system.

Figure 18. Light curing of the adhesive system.

The clinical management strategy for posterior restorative defects is centered on preserving dental structure and function through careful assessment and minimally invasive intervention tailored to the specific characteristics of each situation.

 DOI: 10.58179/RJDR2401

Figure 19. Applying the adhesive system.

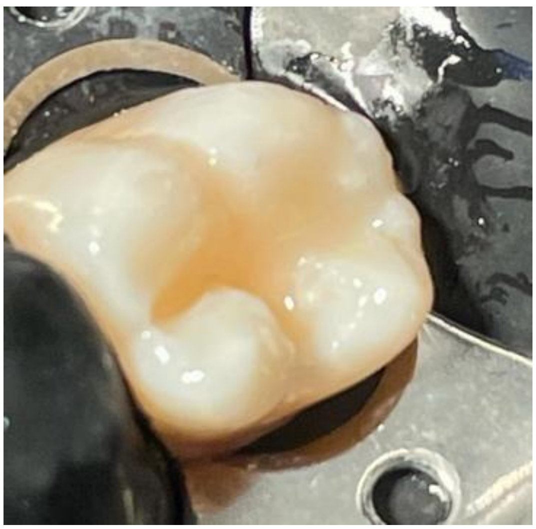

Figure 20. Applying the adhesive system.

In a context involving the detection of compromised structural integrity at tooth 4.6, clinical examination showed a fracture of the physiognomic restoration, with evident material loss affecting the occlusal surface (Figure 19).

Because the filling showed infiltration at the marginal contour, we preferred to remove the entire filling and prepare a class I A cavity (Figure 20).

Figure 21. Light curing of the adhesive system.

By following the isolation and filling steps mentioned in the Material and Method chapter, the cavity was filled, restoring the coronal morphology (Figure 21).

4. Discussion

The American Dental Association states that a restorative material intended for posterior teeth should have a success rate of at least 90% after 18 months of application [15]. Two-year results from a multicenter clinical study reported similar survival rates for restorations performed with glass ionomer cement (GIC) and resin-modified nanohybrid composites, at 93.6% and 94.5%, respectively, when evaluating Class II two-surface restorations in molars [16].

Similarly, other studies have reported comparable clinical performance for restorations using GIC and microfilled hybrid composites in extensive Class II cavities over a 24-month evaluation period [17]. A survival rate of 98% was observed for GIC restorations in hypomineralized permanent molars [18]. However, a longitudinal study reported a significantly lower survival rate for hybrid glass ionomer Class II restorations compared to conventional GIC and bulk-fill composites [19].

 DOI: 10.58179/RJDR2401

Oz et al. compared Cention N (CN) with a resin-enhanced composite for the restoration of Class II cavities. After one year, three CN restorations failed, and seven (18%) presented marginal adaptation issues [20]. Cieplik et al. compared the one-year performance of a new self-adhesive bulk-fill restorative material (SABF) with a conventional bulk-fill resin composite for Class II restorations. They concluded that both materials were clinically acceptable according to FDI criteria. However, SABF showed reduced surface gloss, color changes, decreased translucency, and more pronounced marginal discoloration [21].

Some studies indicate that GIC and composites demonstrate similar clinical performance for most evaluated criteria, except for the presence of secondary carious lesions, where GIC especially resin-modified GIC combined with rubber dam isolation performed better [22].

The choice of restorative material depends on the depth of the carious lesion and the condition of the dentin at the pulpal wall. Traditionally, caries management involved complete removal of demineralized dentin before placing the restoration. However, the benefits of complete removal of affected dentin have been questioned due to concerns about potential adverse effects on the dental pulp. Several studies have challenged this approach, testing different techniques for managing carious dentin. Stepwise excavation involves removing dentin in stages over two visits, allowing the dental pulp time to deposit reparative dentin. Partial removal preserves a portion of the affected dentin and seals the carious lesion in permanent teeth. Another approach involves not removing carious dentin before sealing or restoring, relying on sealing to arrest lesion progression [23,24].

Proximal dental lesions confined to dentin have traditionally been managed through invasive means, including surgical intervention and restoration. Non-invasive alternatives, such as sealants, fluoride varnish applications, or floss impregnated with fluoride, could potentially prevent enamel demineralization; however, their effectiveness depends on the patient’s caries risk. Recently, micro-invasive approaches have been attempted for the management of proximal carious lesions. These interventions involve creating a barrier either above (sealing) or within (infiltration) the lesion. Various methods and materials are currently available for micro-invasive treatments, including resin-based sealants (e.g., polyurethane), patch/strip systems, glass ionomer cements (GIC), or adhesive resin infiltration [25].

However, non-invasive alternatives are applicable only to lesions confined to enamel, while lesions extending beyond the enamel–dentin junction have not yet been fully evaluated in terms of the potential for remineralization of the affected dental hard tissues [26,27]. Several studies have indicated that radiographically visible lesions extending into outer dentin represent either a contraindication for resin infiltration techniques or a clear indication for surgical treatment [28,29].

The depth of the lesion observed radiographically correlates with the level of bacterial infection, which applies equally to both non-cavitated and inactive lesions, as well as with the accumulation of proteins, microbial metabolic products, lipids, polysaccharides, and/or other salivary or

 DOI: 10.58179/RJDR2401

dietary infiltrates. All these factors have a negative impact, likely hindering complete remineralization [30-37].

Dentin caries can be removed via an occlusal approach, while enamel caries may be remineralized through infiltration both from within the cavity and from the proximal site, thereby occluding the porous enamel lesion areas through capillary infiltration. Remineralization could lead to stabilization of weakened proximal enamel and should result in increased clinical success rates [28,29].

A Class II cavity can be prepared in several ways. Tunnel preparation offers greater mechanical advantage compared to conventional Class II cavity preparation or drop/slot preparation methods, thereby protecting the restored tooth from potential fracture. Combining tunnel preparation with resin infiltration could further enhance tooth strength while still representing a minimally invasive approach for managing proximal caries. Undoubtedly, the biomechanical performance of the restored tooth would be improved by employing this method [38].

Composite restorations for Class II cavities are more frequently placed subgingivally, at the cement–enamel junction, and those placed in dentin are more prone to bacterial microleakage [39]. One of the major disadvantages of restoring posterior teeth with resin composites is the lack of adaptation of the material to the tooth structure, particularly at the gingival floor [40].

Especially when the bond to dentin is weaker, polymerization shrinkage of the material can result in the formation of a gap between the cavity walls and the composite resin. This gap facilitates bacterial microleakage, allowing the infiltration of bacteria and oral fluids from the oral cavity. Bacterial microleakage can lead to postoperative sensitivity, pulpal inflammation, and secondary caries [41].

Recently, a new category of composites called nanocomposites has been developed [42]. Restorative composite systems utilizing nanotechnology offer high translucency and improved polishability [43,44]. Clinically, nanocomposites exhibit adequate strength in high-stress areas typical of posterior teeth, making them as durable as hybrid and microhybrid composites [43-45].

Flowable composites have been recommended for application beneath paste-type resin composites due to their low viscosity, elasticity, and improved infiltration into dentin. These application characteristics, combined with a syringe delivery system, make flowable composites an ideal choice for use in the sandwich technique. They are placed on the gingival floor of proximal Class II restorations as a liner, improving final marginal adaptation and resulting in reduced microleakage and postoperative sensitivity [43-47].

Composites have a relatively high modulus of elasticity, and it has been suggested that this rigidity contributes to their inability to compensate for polymerization shrinkage stress. This may lead to failure of the composite-tooth bond or fracture of the tooth structure, resulting in bacterial microleakage and postoperative sensitivity. The use of an intermediate layer of flowable composite, with a lower modulus of elasticity, can compensate for some of the polymerization shrinkage stress. Some in vitro studies have shown that the use of flowable composites reduces the risk of bacterial

 DOI: 10.58179/RJDR2401

microleakage and the occurrence of secondary caries [48,49].

Flowable compomers are resin-modified composites with polyacid additives, possessing the characteristics of both flowable composites and glass ionomer cements. Flowable compomers are claimed to improve adhesive properties and release fluoride similarly to conventional glass ionomer cements. These materials are also indicated for use at gingival floors, reducing polymerization shrinkage stress in Class II restorations, with properties similar to those of flowable composites, and thereby improving the C-factor [50,51].

The use of nanocomposites allows the creation of aesthetic restorations with adequate strength for direct application in posterior teeth. In a clinical study, Filtek Supreme demonstrated good performance in posterior teeth, similar to the results observed in our study. Although no statistically significant difference in bacterial microleakage was observed between Universal Filtek Supreme XT and Filtek Z250 with or without the addition of flowable composite at the gingival floor, Universal Filtek Supreme XT showed better results than Filtek Z250 in each similar subgroup [42,45,51-54].

Many new techniques and materials have been introduced to reduce polymerization shrinkage stress, such as the incremental layering technique, multi-angle polymerization, and the use of low-elasticity composites as an intermediate layer between the restoration and the tooth structure [55-57].

The dentin replacement material (SDR) is a recently introduced flowable composite that can be used as a liner in Class I and Class II restorations. SDR resin provides an approximate 20% reduction in volumetric shrinkage and an 80% reduction in polymerization stress compared to a conventional resin composite system [58].

The material GC Fuji II LC, a resin-modified glass ionomer, can be used as a liner beneath composite restorations to partially reduce polymerization shrinkage stress of composite restorations. In practice, these cements, whether traditional glass ionomers or resin-modified glass ionomers, ensure better adaptation and act as a flexible stress-absorbing layer between the restoration and the tooth [59].

Numerous studies have tested restorations made with different types of posterior composites using various adhesive techniques and tested composites, such as PRODIGY, Filtek Z250, and Filtek Supreme XT, concluding that there is no significant difference in the clinical performance of composites in posterior restorations [54,59-62].

The findings of the present study indicated that the clinical parameters associated with restorations-including secondary caries, postoperative sensitivity, marginal adaptation, marginal discoloration, color matching, anatomical form, and surface roughness-were clinically acceptable for composite restorations. These results are consistent with those reported in other studies [63-69].

The adaptation of resin-based composite restorations in Class I cavities has been evaluated through marginal microleakage, as it is more challenging for the restorative material to adapt to the deepest areas of the cavity compared to other interface locations [70]. Nevertheless, very good results were

 DOI: 10.58179/RJDR2401

also observed in Class I cavities compared to Class II cavities.

5. Conclusions

Clinical findings indicate that direct light-cured resin composite restorations in posterior teeth demonstrate a high rate of clinical success and a favorable long-term survival time, supporting their use as a material of choice for medium to extensive, and in certain clinical situations, large cavity preparations in posterior teeth. The conducted research revealed that patient gender significantly influences restoration outcomes, particularly in terms of marginal adaptation and the need for repair or complete replacement. Specifically, a higher incidence of restorations requiring repair was observed in female patients compared to male patients.

Repairs were more frequently associated with cases involving dental abrasion and secondary caries, whereas fractures and dental erosion were less common indications for repair. Restoration replacement was most often necessary in cases with secondary caries or dental erosion.

References

1. Gugnani N, Pandit IK, Srivastava N, Gupta M, Sharma M. International Caries Detection and Assessment System (ICDAS): A New Concept. Int J Clin Pediatr Dent. 2011 May-Aug;4(2):93-100. doi: 10.5005/jp-journals-10005-1089. Epub 2010 Apr 15.
2. Bagramian RA, Garcia-Godoy F, Volpe AR. The global increase in dental caries. A pending public health crisis. Am J Dent. 2009 Feb;22(1):3-8. PMID: 19281105.
3. Costa SM, Martins CC, Bonfim Mde L, Zina LG, Paiva SM, Pordeus IA, Abreu MH. A systematic review of socioeconomic indicators and dental caries in adults. Int J Environ Res Public Health. 2012 Oct 10;9(10):3540-74. doi: 10.3390/ijerph9103540.
4. Borgia E, Baron R, Borgia JL. Quality and Survival of Direct Light-Activated Composite Resin Restorations in Posterior Teeth: A 5- to 20-Year Retrospective Longitudinal Study. J Prosthodont. 2019 Jan;28(1):e195-e203. doi: 10.1111/jopr.12630.
5. Rasines Alcaraz MG, Veitz-Keenan A, Sahrmann P, Schmidlin PR, Davis D, Iheozor-Ejiofor Z. Direct composite resin fillings versus amalgam fillings for permanent or adult posterior teeth. Cochrane Database Syst Rev. 2014 Mar 31;(3):CD005620. doi: 10.1002/14651858.CD005620.pub2. Update in: Cochrane Database Syst Rev. 2021 Aug 13;8:CD005620. doi: 10.1002/14651858.CD005620.pub3. PMID: 24683067.
6. Pinto Gdos S, Oliveira LJ, Romano AR, Schardosim LR, Bonow ML, Pacce M, Correa MB, Demarco FF, Torriani DD. Longevity of posterior restorations in primary teeth: results from a paediatric dental clinic. J Dent. 2014 Oct;42(10):1248-54. doi: 10.1016/j.jdent.2014.08.005. Epub 2014 Aug 20. PMID: 25150105.
7. Kupietzky A, Atia Joachim D, Tal E, Moskovitz M. Long-term clinical performance of heat-cured high-viscosity glass ionomer class II restorations versus resin-based composites in primary molars: a randomized comparison trial. Eur Arch Paediatr Dent. 2019 Oct;20(5):451-456. doi: 10.1007/s40368-019-00423-x. Epub 2019 Feb 28. PMID: 30820833.

8. Hatirli H, Yasa B, Çelik EU. Clinical performance of high-viscosity glass ionomer and resin composite on minimally invasive occlusal restorations performed without rubber-dam isolation: a two-year randomised split-mouth study. Clin Oral Investig. 2021 Sep;25(9):5493-5503. doi: 10.1007/s00784-021-03857-0. Epub 2021 Mar 8. PMID: 33683465.
9. Vetromilla BM, Opdam NJ, Leida FL, Sarkis-Onofre R, Demarco FF, van der Loo MPJ, Cenci MS, Pereira-Cenci T. Treatment options for large posterior restorations: a systematic review and network meta-analysis. J Am Dent Assoc. 2020 Aug;151(8):614-624.e18. doi: 10.1016/j.adaj.2020.05.006. PMID: 32718491.
10. Zhang J, Braun P, Banerjee A. In vitro compressive strength and edge stability testing of directly repaired glass-ionomer cements. Clin Oral Investig. 2020 Sep;24(9):3029-3038. doi: 10.1007/s00784-019-03170-x. Epub 2019 Dec 17. PMID: 31845069.
11. Spagnuolo G. Bioactive Dental Materials: The Current Status. Materials (Basel). 2022 Mar 9;15(6):2016. doi: 10.3390/ma15062016. PMID: 35329471; PMCID: PMC8955510.
12. Friedl K, Hiller KA, Friedl KH. Clinical performance of a new glass ionomer based restoration system: a retrospective cohort study. Dent Mater. 2011 Oct;27(10):1031-7. doi: 10.1016/j.dental.2011.07.004. Epub 2011 Aug 15. PMID: 21840585.
13. Ekstrand KR, Luna LE, Promisiero L, Cortes A, Cuevas S, Reyes JF, Torres CE, Martignon S. The reliability and accuracy of two methods for proximal caries detection and depth on directly visible proximal surfaces: an in vitro study. Caries Res. 2011;45(2):93-9. doi: 10.1159/000324439. Epub 2011 Mar 16. PMID: 21412000.
14. Henneberg S, Henriksen J, Christensen L, Markvart M, Rosing K. Inconsistent decision making in dental caries diagnosis and treatment: A case-based questionnaire survey. Health Sci Rep. 2024 Sep 5;7(9):e2278. doi: 10.1002/hsr2.2278. PMID: 39246726; PMCID: PMC11377301.
15. Statement on posterior resin-based composites. ADA Council on Scientific Affairs; ADA Council on Dental Benefit Programs. J Am Dent Assoc. 1998 Nov;129(11):1627-8. PMID: 9818585.
16. Miletić I, Baraba A, Basso M, Pulcini MG, Marković D, Perić T, Ozkaya CA, Turkun LS. Clinical Performance of a Glass-Hybrid System Compared with a Resin Composite in the Posterior Region: Results of a 2-year Multicenter Study. J Adhes Dent. 2020;22(3):235-247. doi: 10.3290/j.jad.a44547. PMID: 32435764.
17. Gurgan S, Kutuk ZB, Ozturk C, Soleimani R, Cakir FY. Clinical Performance of a Glass Hybrid Restorative in Extended Size Class II Cavities. Oper Dent. 2020 May/Jun;45(3):243-254. doi: 10.2341/18-282-C. Epub 2019 Oct 29. PMID: 31661352.
18. Grossi JA, Cabral RN, Ribeiro APD, Leal SC. Glass hybrid restorations as an alternative for restoring hypomineralized molars in the ART model. BMC Oral Health. 2018 Apr 18;18(1):65. doi: 10.1186/s12903-018-0528-0. PMID: 29669561; PMCID: PMC5907471.
19. Balkaya H, Arslan S. A Two-year Clinical Comparison of Three Different Restorative Materials in Class II Cavities. Oper Dent. 2020 Jan/Feb;45(1):E32-E42. doi: 10.2341/19-078-C. Epub 2019 Nov 18. PMID: 31738696.
20. Oz FD, Meral E, Gurgan S. Clinical performance of an alkasite-based bioactive restorative in class II cavities: a randomized clinical trial. J Appl Oral Sci. 2023 Jun 23;31:e20230025. doi: 10.1590/1678-7757-

2023-0025. PMID: 37377309; PMCID: PMC10343945.

21. Cieplik F, Scholz KJ, Anthony JC, Tabenski I, Ettenberger S, Hiller KA, Buchalla W, Federlin M. One-year results of a novel self-adhesive bulk-fill restorative and a conventional bulk-fill composite in class II cavities-a randomized clinical split-mouth study. Clin Oral Investig. 2022 Jan;26(1):449-461. doi: 10.1007/s00784-021-04019-y. Epub 2021 Jun 15. PMID: 34129074; PMCID: PMC8791912.
22. Dias AGA, Magno MB, Delbem ACB, Cunha RF, Maia LC, Pessan JP. Clinical performance of glass ionomer cement and composite resin in Class II restorations in primary teeth: A systematic review and meta-analysis. J Dent. 2018 Jun;73:1-13. doi: 10.1016/j.jdent.2018.04.004. Epub 2018 Apr 9. PMID: 29649506.
23. Ricketts D, Lamont T, Innes NP, Kidd E, Clarkson JE. Operative caries management in adults and children. Cochrane Database Syst Rev. 2013 Mar 28;(3):CD003808. doi: 10.1002/14651858.CD003808.pub3. Update in: Cochrane Database Syst Rev. 2019 Jul 24;7:CD003808. doi: 10.1002/14651858.CD003808.pub4. PMID: 23543523.
24. Schwendicke F, Walsh T, Lamont T, Al-Yaseen W, Bjørndal L, Clarkson JE, Fontana M, Gomez Rossi J, Göstemeyer G, Levey C, Müller A, Ricketts D, Robertson M, Santamaria RM, Innes NP. Interventions for treating cavitated or dentine carious lesions. Cochrane Database Syst Rev. 2021 Jul 19;7(7):CD013039. doi: 10.1002/14651858.CD013039.pub2. PMID: 34280957; PMCID: PMC8406990.
25. Dorri M, Dunne SM, Walsh T, Schwendicke F. Micro-invasive interventions for managing proximal dental decay in primary and permanent teeth. Cochrane Database Syst Rev. 2015 Nov 5;2015(11):CD010431. doi: 10.1002/14651858.CD010431.pub2. PMID: 26545080; PMCID: PMC8504982.
26. Kielbassa AM, Ulrich I, Treven L, Mueller J. An updated review on the resin infiltration technique of incipient proximal enamel lesions. Med. Evol. 2010;16:3–15. doi: 10.13140/RG.2.2.36646.37443.
27. Kielbassa AM, Muller J, Gernhardt CR. Closing the gap between oral hygiene and minimally invasive dentistry: a review on the resin infiltration technique of incipient (proximal) enamel lesions. Quintessence Int. 2009 Sep;40(8):663-81. PMID: 19639091.
28. Kielbassa AM, Leimer MR, Hartmann J, Harm S, Pasztorek M, Ulrich IB. Ex vivo investigation on internal tunnel approach/internal resin infiltration and external nanosilver-modified resin infiltration of proximal caries exceeding into dentin. PLoS One. 2020 Jan 28;15(1):e0228249. doi: 10.1371/journal. pone.0228249.
29. Kielbassa AM, Ulrich I, Werth VD, Schüller C, Frank W, Schmidl R. External and internal resin infiltration of natural proximal subsurface caries lesions: A valuable enhancement of the internal tunnel restoration. Quintessence Int. 2017;48(5):357-368. doi: 10.3290/j.qi.a37799. PMID: 28294198.
30. Bakhshandeh A, Floriano I, Braga MM, Thorlacius KA, Ekstrand KR. Relationship between depth of approximal caries lesions and presence of bacteria in the dentine in primary and permanent posterior teeth: a radiographic examination with microbiological evaluation. Acta Odontol Scand. 2018 Oct;76(7):509-514. doi: 10.1080/00016357.2018.1444201. Epub 2018 Feb 27. PMID: 29484911.
31. Parolo CC, Maltz M. Microbial contamination of noncavitated caries lesions: a scanning electron microscopic study. Caries Res. 2006;40(6):536-41.

32. Ricucci D, Siqueira JF Jr. Bacteriologic status of non-cavitated proximal enamel caries lesions. A histologic and histobacteriologic study. J Dent. 2020 Sep;100:103422. doi: 10.1016/j.jdent.2020.103422. Epub 2020 Jun 29. PMID: 32615236.
33. Flemming J, Hannig C, Hannig M. Caries Management-The Role of Surface Interactions in De- and Remineralization-Processes. J Clin Med. 2022 Nov 28;11(23):7044. doi: 10.3390/jcm11237044. PMID: 36498618; PMCID: PMC9737279.
34. Damen JJ, ten Cate JM. Inhibition of hydroxyapatite crystal growth by lipoteichoic acid. Arch Oral Biol. 1994 Feb;39(2):141-6. doi: 10.1016/0003-9969(94)90109-0. PMID: 8185499.
35. Bibby BG. Organic enamel material and caries. Caries Res. 1971;5(4):305-22. doi: 10.1159/000259759. PMID: 4943288.
36. de Sousa FB, Lelis IMP, Figueiredo RCBQ, Pires AC, Gerlach RF. Quantitative study of the proportion of the pore volume of human fluorotic enamel filled by resin infiltrant. Arch Oral Biol. 2017 Oct;82:134-140. doi: 10.1016/j.archoralbio.2017.06.017. Epub 2017 Jun 15. PMID: 28641179.
37. Robinson C, Shore RC, Brookes SJ, Strafford S, Wood SR, Kirkham J. The chemistry of enamel caries. Crit Rev Oral Biol Med. 2000;11(4):481-95. doi: 10.1177/10454411000110040601. PMID: 11132767.
38. Ouldyerou A, Mehboob H, Mehboob A, Merdji A, Aminallah L, Mukdadi OM, Barsoum I, Junaedi H. Biomechanical performance of resin composite on dental tissue restoration: A finite element analysis. PLoS One. 2023 Dec 21;18(12):e0295582. doi: 10.1371/journal.pone.0295582. PMID: 38128035; PMCID: PMC10734934.
39. Sadeghi M. Influence of flowable materials on microleakage of nanofilled and hybrid Class II composite restorations with LED and QTH LCUs. Indian J Dent Res. 2009 Apr-Jun;20(2):159-63. doi: 10.4103/0970-9290.52891. PMID: 19553715.
40. Sadeghi M. The effect of fluid composite as gingival layer on microleakage of class II composite restorations Dental Res J. 2007;4:40–7.
41. Attar N, Korkmaz Y. Effect of two light-emitting diode (LED) and one halogen curing light on the microleakage of Class V flowable composite restorations. J Contemp Dent Pract. 2007 Feb 1;8(2):80-8. PMID: 17277830.
42. Dresch W, Volpato S, Gomes JC, Ribeiro NR, Reis A, Loguercio AD. Clinical evaluation of a nanofilled composite in posterior teeth: 12-month results. Oper Dent. 2006 Jul-Aug;31(4):409-17. doi: 10.2341/05-103. PMID: 16924980.
43. Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc. 2003 Oct;134(10):1382-90. doi: 10.14219/jada.archive.2003.0054. PMID: 14620019.
44. Saravana KR, Vijayalakshmi R. Nanotechnology in dentistry. Indian J Dent Res. 2006 Apr-Jun;17(2):62-5. doi: 10.4103/0970-9290.29890. PMID: 17051869.
45. Lopes GC, Oliveira GM. Direct composite resin restorations in posterior teeth. Compend Contin Educ Dent. 2006 Oct;27(10):572-9; quiz 580-1. PMID: 17120391.
46. Neme AM, Maxson BB, Pink FE, Aksu MN. Microleakage of Class II packable resin composites lined with flowables: an in vitro study. Oper Dent. 2002 Nov-Dec;27(6):600-5. PMID: 12413226.
47. Tredwin CJ, Stokes A, Moles DR. Influence of flowable liner and margin location on microleakage of conventional and packable

class II resin composites. Oper Dent. 2005 Jan-Feb;30(1):32-8. PMID: 15765955.
48. Attar N, Tam LE, McComb D. Flow, strength, stiffness and radiopacity of flowable resin composites. J Can Dent Assoc. 2003 Sep;69(8):516-21. PMID: 12954140.
49. Qin M, Liu H. Clinical evaluation of a flowable resin composite and flowable compomer for preventive resin restorations. Oper Dent. 2005 Sep-Oct;30(5):580-7. PMID: 16268391.
50. Owens BM, Rodriguez KH. Radiometric and spectrophotometric analysis of third generation light-emitting diode (LED) light-curing units. J Contemp Dent Pract. 2007 Feb 1;8(2):43-51. PMID: 17277826.
51. Civelek A, Ersoy M, L'Hotelier E, Soyman M, Say EC. Polymerization shrinkage and microleakage in Class II cavities of various resin composites. Oper Dent. 2003 Sep-Oct;28(5):635-41. PMID: 14531612.
52. Ziskind D, Adell I, Teperovich E, Peretz B. The effect of an intermediate layer of flowable composite resin on microleakage in packable composite restorations. Int J Paediatr Dent. 2005 Sep;15(5):349-54. doi: 10.1111/j.1365-263X.2005.00663.x. PMID: 16128999.
53. Sadeghi M, Lynch CD. The effect of flowable materials on the microleakage of Class II composite restorations that extend apical to the cemento-enamel junction. Oper Dent. 2009 May-Jun;34(3):306-11. doi: 10.2341/08-91. PMID: 19544820.
54. Kasraei S, Azarsina M, Majidi S. In vitro comparison of microleakage of posterior resin composites with and without liner using two-step etch-and-rinse and self-etch dentin adhesive systems. Oper Dent. 2011 Mar-Apr;36(2):213-21. doi: 10.2341/10-215-L. Epub 2011 Jun 24. PMID: 21702678.
55. Baracco B, Perdigão J, Cabrera E, Ceballos L. Two-year clinical performance of a low-shrinkage composite in posterior restorations. Oper Dent. 2013 Nov-Dec;38(6):591-600. doi: 10.2341/12-364-C. Epub 2013 Apr 9. PMID: 23570300.
56. Sampaio PC, de Almeida Júnior AA, Francisconi LF, Casas-Apayco LC, Pereira JC, Wang L, Atta MT. Effect of conventional and resin-modified glass-ionomer liner on dentin adhesive interface of Class I cavity walls after thermocycling. Oper Dent. 2011 Jul-Aug;36(4):403-12. doi: 10.2341/09-240-L. PMID: 21913841.
57. Medina-Sotomayor P, Ortega G, Aguilar J, Ordóñez P, Rojas M, Vásquez R. Dental restoration operative time and analysis of the internal gap of conventional resins (Incremental Technique) vs. Bulk Fill (Single-Increment Technique): In vitro study. J Clin Exp Dent. 2023 Aug 1;15(8):e621-e628. doi: 10.4317/jced.60717. PMID: 37674607; PMCID: PMC10478196.
58. El-Damanhoury H, Platt J. Polymerization shrinkage stress kinetics and related properties of bulk-fill resin composites. Oper Dent. 2014 Jul-Aug;39(4):374-82. doi: 10.2341/13-017-L. Epub 2013 Jul 18. PMID: 23865582.
59. Lopes LG, Cefaly DF, Franco EB, Mondelli RF, Lauris JR, Navarro MF. Clinical evaluation of two "packable" posterior composite resins: two-year results. Clin Oral Investig. 2003 Sep;7(3):123-8. doi: 10.1007/s00784-003-0218-3. Epub 2003 Aug 12. PMID: 12915962.
60. Banomyong D, Harnirattisai C, Burrow MF. Posterior resin composite restorations with or without resin-modified, glass-ionomer cement lining: a 1-year randomized, clinical trial. J Investig Clin Dent. 2011 Feb;2(1):63-9. doi: 10.1111/j.2041-1626.2010.00036.x. Epub 2010 Nov 10. PMID: 25427330.
61. Loguercio AD, Zago C, Leal K, Ribeiro NR, Reis A. One-year clinical evaluation of a flowable resin liner associated with a microhybrid resin in noncarious cervical

lesions. Clin Oral Investig. 2005 Mar;9(1):18-20. doi: 10.1007/s00784-004-0287-y. Epub 2004 Nov 10. PMID: 15549496.

62. Burrow MF, Tyas MJ. Clinical evaluation of three adhesive systems for the restoration of non-carious cervical lesions. Oper Dent. 2007 Jan-Feb;32(1):11-5. doi: 10.2341/06-50. PMID: 17288323.
63. Suhasini K, Madhusudhana K, Suneelkumar C, Lavanya A, Chandrababu KS, Kumar PD. Clinical performance of Class I nanohybrid composite restorations with resin-modified glass-ionomer liner and flowable composite liner: A randomized clinical trial. J Conserv Dent. 2016 Nov-Dec;19(6):510-515. doi: 10.4103/0972-0707.194030. PMID: 27994310; PMCID: PMC5146764.
64. Mahmoud SH, El-Embaby AE, AbdAllah AM. Clinical performance of ormocer, nanofilled, and nanoceramic resin composites in Class I and Class II restorations: a three-year evaluation. Oper Dent. 2014 Jan-Feb;39(1):32-42. doi: 10.2341/12-313-C. Epub 2013 Apr 24. PMID: 23614660.
65. Ozgünaltay G, Görücü J. Fracture resistance of class II packable composite restorations with and without flowable liners. J Oral Rehabil. 2005 Feb;32(2):111-5. doi: 10.1111/j.1365-2842.2004.01364.x. PMID: 15641976.
66. Pecie R, Onisor I, Krejci I, Bortolotto T. Marginal adaptation of direct class II composite restorations with different cavity liners. Oper Dent. 2013 Nov-Dec;38(6):E210-20. doi: 10.2341/12-229-L. Epub 2013 May 28. PMID: 23713806.
67. Al-Nahedh HN. Effects of Resin-modified Glass Ionomer Cement and Flowable Bulk-fill Base on the Fracture Resistance of Class II Restorations: An Original Laboratory Experimental Study. J Contemp Dent Pract. 2021 Apr 1;22(4):342-348. PMID: 34267000.
68. Al-Harbi F, Kaisarly D, Michna A, ArRejaie A, Bader D, El Gezawi M. Cervical Interfacial Bonding Effectiveness of Class II Bulk Versus Incremental Fill Resin Composite Restorations. Oper Dent. 2015 Nov-Dec;40(6):622-35. doi: 10.2341/14-152-L. Epub 2015 Jul 7. PMID: 26151459.
69. Duarte JCL, Costa AR, Veríssimo C, Duarte RW, Calabrez Filho S, Spohr AM, Borges GA, Correr-Sobrinho L. Interfacial Stress and Bond Strength of Bulk-Fill or Conventional Composite Resins to Dentin in Class II Restorations. Braz Dent J. 2020 Sep-Oct;31(5):532-539. doi: 10.1590/0103-6440202003338. PMID: 33146338.
70. Han SH, Park SH. Comparison of Internal Adaptation in Class II Bulk-fill Composite Restorations Using Micro-CT. Oper Dent. 2017 Mar/Apr;42(2):203-214. doi: 10.2341/16-023-L. Epub 2016 Nov 28. PMID: 27892836.

Author contributions

Authors read and approved the final manuscript. All authors have equally contributed to this work.

Acknowledgements

Not applicable.

Funding information

No source of external funding was received for the completion of this study.

Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

This study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova (approval data no. 412/04.11.2025).

ORCID

Alexandru-Dan Popescu: https://orcid.org/0000-0003-3210-1212
Jaqueline Popescu: https://orcid.org/0009-0009-6707-7882
Ana-Maria Rîcă: https://orcid.org/0000-0001-5139-4247
Adelina Smaranda Bugălă: https://orcid.org/0009-0009-9667-4715
Oana Andreea Diaconu: https://orcid.org/0009-0009-1547-2864
Anca Gheorghe: https://orcid.org/0009-0007-6096-3510
Carina Bănică: https://orcid.org/0009-0000-5283-9949
Mihaela Jana Ţuculină: https://orcid.org/0000-0002-6535-3152

How to cite:
Popescu AD, Ţuculină MJ, Molea B, Popescu J, Bugălă AS, Rîcă AM, Staicu AN, Gheorghe A, Bănică C, Gheorghiță LM, Petrache A and Diaconu OA. Clinical management of marginal defects in adhesive restorations. Rom J Dent Res. 2025. 2(4):6-26.