Journal of Applied Dental and Medical Sciences
NLM ID: 101671413 ISSN: 2454-2288
Volume 12 Issue 2 April-June 2026

Original Research

From Adaptation to Reinforcement: A Comparative Evaluation of Microleakage in Class II Composite Restorations Using Progressive Restorative Strategies: An In Vitro Study

Yashwani jain [1], Santosh Kumar Singh [2], Pankaj Mishra [3], Shubhashree Rajput [4], Sakshi agrawal [5], Kapil Malviya[6]

[1,4,5,6] Post Graduate Student, Department of Conservative Dentistry and Endodontics,, People's College of Dental Sciences, Bhopal, Madhya Pradesh

[2] Professor and Head, Department of Conservative Dentistry and Endodontics,, People's College of Dental Sciences, Bhopal, Madhya Pradesh

[3] Professor , Department of Conservative Dentistry and Endodontics,, People's College of Dental Sciences, Bhopal, Madhya Pradesh

A R T I C L E I N F O

Keywords: Microleakage; Class II restoration; snowplow technique; stress-reduced direct composite; polyethylene fibre; dye penetration.

A B S T R A C T

Background: Polymerization shrinkage in resin-based composites can lead to compromise of the tooth–restoration interface, particularly in Class II cavities where gingival margins are often located in dentin. Modifications in restorative technique aim to enhance marginal adaptation, reduce microleakage & minimise interfacial gap without necessarily altering the restorative material. **Aim:** To comparatively evaluate microleakage in Class II composite restorations using progressive restorative techniques. **Materials and Methods:** 48 extracted human premolars were selected and standardized Class II (mesio-occlusal/distal-occlusal) cavities were prepared with gingival margins positioned 1 mm below the cementoenamel junction. The samples were randomly allocated into four groups (n = 12): Group I – conventional incremental technique (control), Group II – snowplow technique, Group III – stress-reduced direct composite (SRDC) technique, and Group IV – SRDC with polyethylene fibre interposition. A uniform adhesive protocol and the same composite restorative material were used for all specimens. After restoration, samples were stored in distilled water for 24 hours and subjected to thermocycling between 5°C and 55°C. The teeth were then coated with nail varnish except for a 1 mm window around the restoration margins and immersed in 2% methylene blue dye for 24 hours. Specimens were sectioned bucco-lingually through the proximal box and evaluated under a stereomicroscope at 4x magnification. Microleakage was assessed using a 0–3 scoring system based on the extent of dye penetration from the gingival margin toward the axial wall. Data were analyzed using parametric statistical tests with significance set at $p < 0.05$. **Results:** The Conventional Incremental Technique demonstrated the highest degree of dye penetration indicating the poorest marginal seal. The Snowplow Technique exhibited moderate dye penetration, suggesting improved adaptation compared with the conventional technique. The SRDC Technique showed only superficial dye penetration , reflecting better marginal integrity. The SRDC with Polyethylene Fibre Technique demonstrated the least microleakage, indicating superior marginal adaptation and sealing ability. **Conclusion:** The results suggest that the incorporation of stress-reduction strategies significantly improves marginal sealing in Class II composite restorations. Furthermore, the addition of polyethylene fibre reinforcement to the SRDC protocol appears to offer the greatest resistance to microleakage, indicating its potential value as an adjunctive restorative approach for improving restoration longevity.

Introduction

Resin-based composite materials have become the preferred choice for restoring posterior teeth due to their favorable esthetics, adhesive capability, and conservative preparation requirements.

Perfect adaptation of restorative material to the tooth surface should be acquired while setting, and maintained during thermal and mechanical cycling in function. But unfortunately materials such as resin composites exhibit inherent limitations where the dimensional stability of

* Corresponding author: Dr. Yashwani Jain, Post Graduate Student, Department of Conservative Dentistry and Endodontics,, People's College of Dental Sciences, Bhopal, Madhya Pradesh. Email: yashwanijain225@gmail.com

the restorative material is compromised by the polymerization reaction of the matrix phase. The conversion of the monomer molecules into a polymer network is accompanied by increased molecular density leading to volumetric contraction.

Hence, despite continuous advancements in material science, polymerization shrinkage remains a significant challenge associated with composite restorations, particularly in Class II cavities where margins often extend into dentin or cementum. The polymerization shrinkage taking place under confinement generates contraction stress in the restorations which can compromise the tooth–restoration interface, leading to marginal gap formation, postoperative sensitivity, secondary caries, and ultimately restoration failure [1,2]

Microleakage can be defined as the clinically undetectable passage of bacteria, molecules, fluids or ions between the cavity wall and the restorative material. It is broadly used as an indirect measure of the sealing ability of restorative techniques and materials[3].Amongst various methods available for its detection dye penetration is one of the most commonly employed technique as the procedure is validated ,easy to perform, shows quick diffusion in cracks or imperfections & shows reproducibility in in vitro studies [4]. In Class II restorations, the gingival margin is particularly susceptible to microleakage because bonding to dentin is less predictable than to enamel, owing to its heterogeneous structure, higher organic content(difficult to dry) & weak smear layer. [5]

Polymerization shrinkage stress is governed not only by the material properties but also by cavity configuration, commonly expressed as the configuration factor (C-factor). Class II cavities exhibit a relatively high C-factor, which restricts the flow of composite during curing and increases interfacial stress.[6] To mitigate these effects, various restorative techniques have been proposed to enhance marginal adaptation and limit stress at the bonded interface.

The conventional incremental placement technique has been widely recommended to minimize polymerization stress by reducing the volume of composite cured at one time and allowing better adaptation to cavity walls[7] However, even with incremental layering, shrinkage stress cannot be completely eliminated.

The snowplow technique was introduced as a modification aimed at improving marginal adaptation. It involves placing an uncured layer of flowable composite beneath packable more viscous composite, allowing it to flow into microscopic irregularities before simultaneous curing. This technique has been shown to reduce void formation and improve adaptation at the gingival margin, although its direct effect on polymerization stress reduction remains limited[8,9]

More advanced approaches, such as the stress-reduced direct composite (SRDC) technique eliminate the polymerization stress by incorporating a precise layering technique and light curing protocol. The advanced adhesive technique of "minimal stress/maximum bond" was described by Magne as a biomimetic technique, because it simulates the stress/strain of natural teeth.[10] It employs a combination of strategies including the use of a flowable liner, oblique incremental layering, controlled curing protocols and adjustment and standardization of occlusal forces. These modifications aim to reduce the overall shrinkage stress by enhancing stress distribution and allowing more favorable polymerization dynamics[11,12]

In addition to these techniques, fibre reinforcement has been explored as a method to enhance the mechanical performance of composite restorations. The incorporation of polyethylene fibres within the composite can act as a stress-absorbing and crack-arresting component, potentially improving marginal integrity and resistance to microleakage[13,14]

Although numerous studies have evaluated individual techniques for reducing microleakage, there is limited literature comparing these approaches in a progressive manner—from conventional placement to advanced stress-modifying and fibre-reinforced techniques—while maintaining a constant restorative material. Such a comparative evaluation is essential to isolate the effect of technique modification on marginal sealing ability without the confounding influence of material variation.

Therefore, the present in vitro study was designed to comparatively evaluate microleakage in Class II composite restorations using progressive restorative techniques, namely conventional incremental placement, snowplow technique, stress-reduced direct composite technique, and SRDC with polyethylene fibre interposition. The outcomes of this study aim to provide insight into the relative effectiveness of these techniques in improving marginal integrity and may guide clinicians in selecting appropriate restorative approaches for posterior composite restorations.

Materials and Methods

Study Design and Sample Selection

This in vitro experimental study was conducted using extracted human premolars. A total of 48 sound premolar teeth, extracted for orthodontic or periodontal reasons, were selected. Teeth exhibiting caries, restorations, cracks, structural defects, or developmental anomalies were excluded. Following extraction, all specimens were cleaned of soft tissue remnants and calculus using hand scalers and stored in distilled water at room temperature until further use to prevent dehydration.

SAMPLE SIZE DETERMINATION

Formula

$$n=\frac{2(Z_{\alpha/2}+Z_{\beta})^2 \sigma^2}{d^2}$$

Wherein,

$Z_{\alpha/2}=1.96, Z_{\beta}=0.84$

$\sigma=0.00944, d=0.0186$

$$n=\frac{2(1.96+0.84)^2 (0.00944)^2}{(0.0186)^2}$$

$n=4.03$

So, minimum sample size = 5 teeth per group

Although the minimum calculated sample size from the previous study was 5 samples per group, the present study will include 12 samples per group (total = 48 teeth). The increase in sample size was undertaken to improve statistical precision, enhance the reliability of in vitro findings, permit robust four-group comparison, compensate for possible specimen loss, and maintain methodological comparability with previously published studies.

METHODOLOGY

Standardized Class II cavities (mesio-occlusal or disto-occlusal) were prepared on all specimens(as shown in figure 8).The preparations were performed using a high-speed handpiece with a cylindrical diamond bur under continuous water irrigation, and the bur was replaced periodically to ensure uniform cutting efficiency.

The occlusal portion of the cavity was prepared to a depth of approximately 1.5–2 mm, while the proximal box extended gingivally to approximately 1 mm below the cemento-enamel junction(as shown in figure 8.1), The buccolingual width of the proximal box was maintained at approximately one-third of the intercuspal distance, and the axial wall depth was standardized to approximately 1–1.5 mm.

Grouping of Samples

The prepared teeth were randomly assigned into four experimental groups (n = 10 each) based on the restorative technique employed:

- **Group I (Control):** Conventional incremental composite technique
- **Group II:** Snowplow technique
- **Group III:** Stress-reduced direct composite (SRDC) technique
- **Group IV:** SRDC technique with polyethylene fibre interposition

Restorative Procedure

All restorations were performed using the same adhesive system and resin composite material to ensure uniformity across all groups. A sectional matrix system with appropriate wedges was used to achieve proper proximal contour and contact.

Following bonding, restorative procedures were carried out as per the assigned group:

• **Group I(Conventional incremental technique):** Composite was placed in increments of approximately 2 mm thickness. Each increment was individually light-cured before placement of the subsequent layer until the cavity was completely restored(as shown in figure 9).

• **Group II (Snowplow technique):** A thin layer of flowable composite was applied to the cavity floor without prior curing. A packable composite was then placed over the uncured flowable layer, and both materials were polymerized simultaneously(as shown in figure 10).

• **Group III (SRDC technique):**

A flowable composite liner was initially placed and light-cured. The cavity was then restored using oblique incremental layering of composite resin. Each increment was polymerized using a controlled curing protocol to minimize shrinkage stress. (as shown in figure 11)

• **Group IV (SRDC with polyethylene fibre):**

The procedure was similar to Group III, with the additional placement of polyethylene fibre within the composite. The fibre was adapted along the internal walls of the cavity and embedded within the composite before curing, ensuring intimate contact with the restorative material(as shown in figure 12)

All restorations were finished and polished using a standardized polishing system after complete polymerization.

Thermocycling

Following restoration, all specimens were stored in distilled water for 24 hours. The samples were then subjected to thermocycling to simulate oral temperature variations. The thermocycling procedure involved repeated exposure to temperatures ranging from 5°C to 55°C with a dwell time of 30 seconds in each bath, for 500 cycles(as shown in figure 13)

Dye Penetration & Sectioning of Specimens

The apices of the teeth were sealed using sticky wax to prevent dye ingress through the root canal. Each specimen was then coated with two layers of nail varnish, leaving a 1 mm window around the restoration margins.

The samples were immersed in a 2% methylene blue dye solution for 24 hours at room temperature (as shown in figure 14) Following dye exposure, the teeth were thoroughly rinsed under running water to remove excess dye and allowed to dry. Each tooth was sectioned in a bucco-lingual direction using a diamond disc under continuous water cooling. The sectioning was performed through the center of the proximal restoration to expose the gingival margin and axial wall. Care was taken to obtain clean and uniform sections without inducing cracks or artifacts.

Evaluation of Microleakage

The sectioned specimens were examined under a stereomicroscope at 4× magnification(as shown in figure 15).Microleakage was assessed based on the extent of dye penetration from the gingival margin toward the axial wall using the following scoring criteria:

- **Score 0:** No dye penetration
- **Score 1:** Dye penetration less than half the cavity depth
- **Score 2:** Dye penetration greater than half the cavity depth but not reaching the axial wall
- **Score 3:** Dye penetration reaching or extending beyond the axial wall

Each specimen was evaluated, and the highest score observed was recorded for analysis.

IMAGES TERIAL USED]

FIGURE 1. COMPOSITE

FIGURE 2.CURING LIGHT

FIGURE 3. TOFFLEMIER RETAINER & MATRIX BAND

FIGURE 4. BURS

FIGURE 5. COMPOSITE INSTRUMENTS

FIGURE 6.BONDING AGENT

FIGURE 7. POLYETHYLENE FIBRE SPLINT

Procedure

Figure 8 CLASS 2 CAVITY

Figure 8.1 MARGIN 2MM BELOW CEJ

Figure 8.2 ETCHANT APPLICATION

Figure 8.3 BONDING AGENT APPLICATION

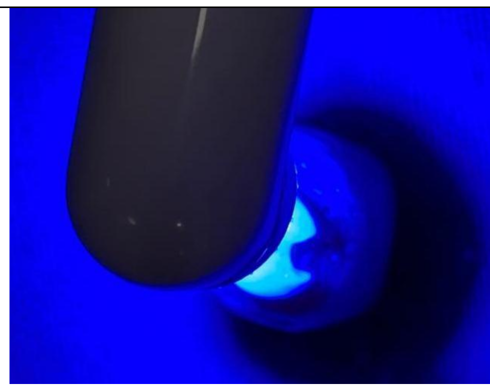


Figure 8.4 CURING OF SPECIMEN

CONVENTIONAL

Figure 9.1 INITIAL INCREMENT

Figure 9.2 FINAL INCREMENT

FIGURE 9. Composite was placed in increments of approximately 2 mm thickness & individually light-cured until the cavity was completely restored

SNOWPLOW

Figure 10.1 FLOWABLE COMPOSITE LAYER

Figure 10.2 PACKABLE COMPOSITE LAYER

Figure 10.3 BOTH LAYERS CO CURED

FIGURE 10. A thin layer of flowable composite was applied to the cavity floor followed by a packable composite placed over the uncured flowable layer, and both materials were polymerized simultaneously.

STRESS REDUCED DIRECT COMPOSITE(SRDC)

FIGURE 11.1 FLOWABLE COMPOSITE LAYER

FIGURE 11.2 OBLIQUE PACKABLE COMPOSITE LAYER

FIGURE 11.3 FINAL INCREMENT

FIGURE 11 A flowable composite liner was initially placed and light-cured. The cavity was then restored using oblique incremental layering of composite resin. Each increment was polymerized using a controlled curing protocol

STRESS REDUCED DIRECT COMPOSITE INTERPOSED WITH FIBRE

FIGURE 12.1 FLOWABLE COMPOSITE LAYER

FIGURE 12.2 POLYETHYLENE FIBRE INTEGRATION

FIGURE 12.3 FINAL INCREMENT

FIGURE 12. The fibre was adapted along the internal walls of the cavity and embedded within the composite before curing, ensuring intimate contact with the restorative material.

FIGURE 13.1 THERMOMETER SHOWING FROM 5°C TEMPERATURE

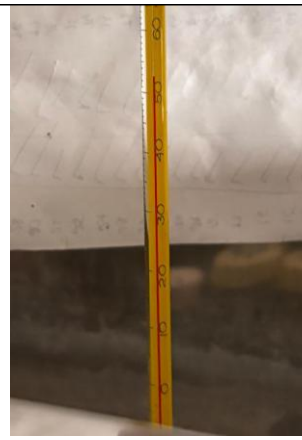


FIGURE 13.2 THERMOMETER SHOWING FROM 55°C TEMPERATURE

Figure 13 : The Thermocycling procedure involved repeated exposure to temperatures ranging from 5 °C to 55 °C with a dwell time of 30 seconds in each bath, for 500 cycles

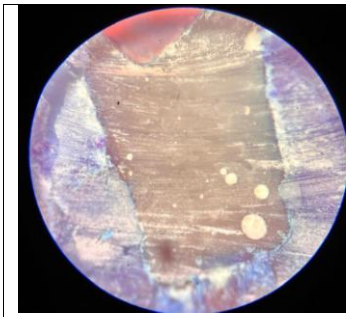
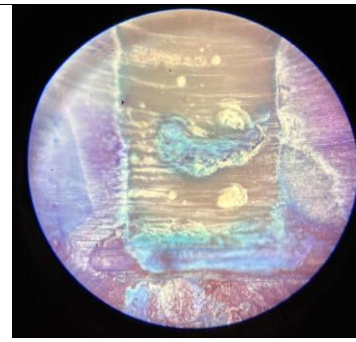
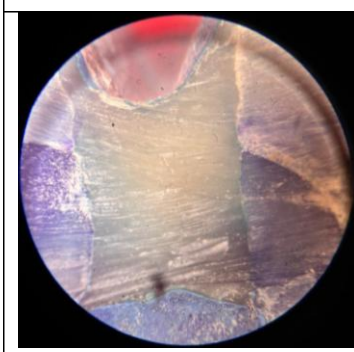
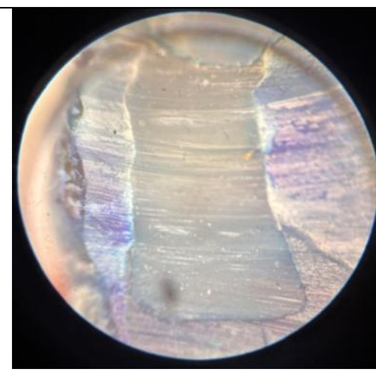
 SCORE 2 [SNOWPLOW]	 SCORE 3[CONVENTIONAL]
 SCORE 0-1[SRDC + FIBRE]	 SCORE 1 [SRDC]

Figure 15: Images of The sectioned specimens examined under a stereomicroscope at 4× magnification

FIGURE 14 : THE SAMPLES WERE IMMERSED IN A 2% METHYLENE BLUE DYE SOLUTION FOR 24 HOURS AT ROOM TEMPERATURE

SCORING OF GROUPS

IMAGE ORDER	ASSIGNED GROUP	SCORE	INTERPRETATION
1.	SNOWPLOW	2	Moderate marginal penetration
2.	CONVENTIONAL	3	Deep continuous dye penetration poorest seal
3	SRDC+FIBRE	0-1	Minimal dye penetration, best adaptation
4.	SRDC	1	Mild superficial leakage

Results

The Conventional Incremental Technique demonstrated the highest degree of dye penetration (Score 3), indicating the poorest marginal seal. The Snowplow Technique exhibited moderate dye penetration (Score 2), suggesting improved adaptation compared with the conventional technique. The SRDC Technique showed only superficial dye penetration (Score 1), reflecting better marginal integrity. The SRDC with Polyethylene Fibre Technique demonstrated the least microleakage, with most specimens showing Score 0 or 1, indicating superior marginal adaptation and sealing ability. These findings suggest that the incorporation of stress-reducing direct composite placement techniques, particularly when reinforced with polyethylene fibres, can effectively reduce marginal leakage in Class II composite restorations.

A statistically significant difference in microleakage scores was observed among the four restorative techniques. The Conventional group showed the highest proportion of severe leakage (Score 3), whereas the SRDC + Fibre group predominantly demonstrated Scores 0 and 1, indicating superior marginal adaptation.

Table 1. Distribution of Microleakage Scores Among Study Groups

Microleakage Score	Conventional (n=12)	Snowplow (n=12)	SRDC (n=12)	SRDC + Fibre (n=12)	Chi-square test	P value
Score 0	0 (0.0%)	0 (0.0%)	2 (16.7%)	7 (58.3%)	28.94	< 0.001*
Score 1	1 (8.3%)	2 (16.7%)	7 (58.3%)	5 (41.7%)		
Score 2	3 (25.0%)	8 (66.7%)	3 (25.0%)	0 (0.0%)		
Score 3	8 (66.7%)	2 (16.7%)	0 (0.0%)	0 (0.0%)		

Table 2. Mean Microleakage Score Comparison Among Groups

Groups	Mean	Standard deviation	95% Confidence Interval		'F' statistic	P value
			Lower bound	Upper bound		
Conventional	2.833	0.389	2.586	3.080	31.76	< 0.001*
Snowplow	2.000	0.603	1.617	2.383		
SRDC	1.083	0.515	0.756	1.410		
SRDC + Fibre	0.417	0.515	0.090	0.744		

*=Significant

The mean microleakage score was highest in the Conventional group (2.833 ± 0.389), followed by the Snowplow group (2.000 ± 0.603). Lower mean scores were observed in the SRDC group (1.083 ± 0.515) and SRDC + Fibre group (0.417 ± 0.515), indicating significantly reduced dye penetration and improved marginal adaptation with the progressive restorative strategies. The difference among the groups was statistically significant ($p < 0.001$).

Graph 1:. Mean Microleakage Score Comparison Among Groups

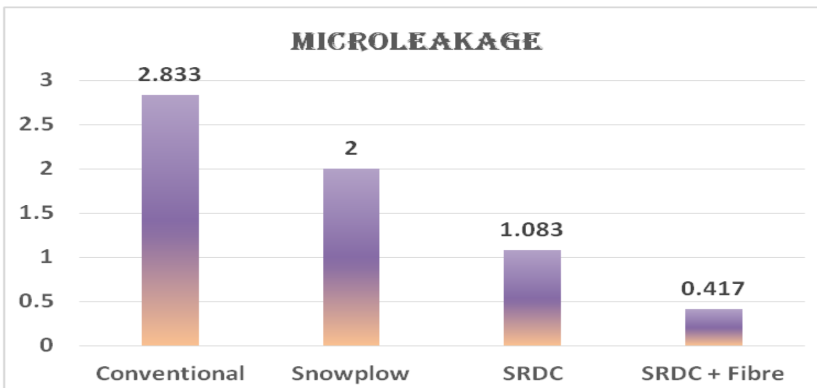


Table 3: Post hoc comparison between groups

Pairs	Mean Difference	Std. Error	Significance
Conventional versus Snowplow	0.833	0.226	0.003*
Conventional versus SRDC	1.750	0.226	<0.001*
Conventional versus SRDC + Fibre	2.416	0.226	<0.001*
Snowplow versus SRDC	0.917	0.226	0.001*
Snowplow versus SRDC + Fibre	1.583	0.226	<0.001*
SRDC versus SRDC + Fibre	0.667	0.226	0.026*

*=Significant

Post hoc analysis revealed statistically significant differences between all study groups. The greatest mean difference was observed between the Conventional and SRDC + Fibre groups (Mean Difference = 2.416, $p < 0.001$), indicating substantially lower microleakage with fibre reinforcement. The SRDC + Fibre group demonstrated significantly better marginal adaptation than all other groups. The SRDC technique also showed significantly lower microleakage than both the Conventional and Snowplow techniques. Overall, the findings suggest a progressive improvement in sealing ability from Conventional restoration to Snowplow, SRDC, and SRDC + Fibre techniques.

Statistical Analysis Plan

The collected data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software 25.0 version. Microleakage scores were recorded for all 48 specimens, with 12 samples in each of the four study groups: Conventional, Snowplow, SRDC, and SRDC + Fibre. Descriptive statistics were used to calculate the mean, standard deviation, and 95% confidence interval of microleakage scores for each group. One-way Analysis of Variance (ANOVA) was applied to compare the mean microleakage scores among the four groups. When a statistically significant difference was observed by ANOVA, post hoc Tukey's Honestly Significant Difference (HSD) test was performed for pairwise comparison between groups.. A p value of less than 0.05 was considered statistically significant.

DISCUSSION

The present in vitro investigation evaluated the effect of four restorative placement techniques on microleakage in Class II composite restorations using dye penetration analysis. The findings demonstrated a statistically significant reduction in microleakage from the Conventional incremental technique to the Snowplow technique, Stress-Reduced Direct Composite (SRDC) technique, and SRDC combined with polyethylene fibre reinforcement. Among all groups, the SRDC + Fibre group exhibited the lowest mean microleakage score, whereas the Conventional group showed the highest degree of marginal leakage.

Polymerization shrinkage remains one of the most important challenges associated with resin composite restorations. During polymerization, conversion of monomer molecules into a cross-linked polymer network results in volumetric contraction, generating stresses at the tooth-restoration interface. When these stresses exceed the bond strength of the adhesive system, marginal gaps may form, facilitating the ingress of fluids, bacteria, and dyes and ultimately leading to microleakage, postoperative sensitivity, and secondary caries formation (15,16). Therefore, restorative techniques capable of minimizing polymerization stress and improving marginal adaptation are expected to demonstrate superior sealing ability.

The Conventional incremental technique exhibited the highest microleakage values in the present study. Although incremental placement is widely recommended to reduce the effects of polymerization shrinkage compared with bulk filling, the technique still generates contraction stresses during curing, particularly at the gingival margin of Class II restorations where bonding occurs predominantly to dentin and cementum (17). Similar findings have been reported by Loguercio et al., who observed increased marginal leakage in conventionally restored Class II cavities due to shrinkage-induced stress concentration at the bonded interfaces (18). The results of the present study therefore support the established understanding that conventional incremental placement may not adequately control interfacial stress development.

The Snowplow technique demonstrated significantly lower microleakage than the Conventional group. This improvement may be attributed to the placement of an uncured flowable composite liner beneath the packable composite. During condensation of the restorative material, the low-viscosity flowable composite is displaced into microscopic surface irregularities and voids, thereby enhancing adaptation at the cavity margins (19). Upon simultaneous curing, a more intimate contact between restoration and tooth structure is achieved. Similar observations have been reported by Chuang et al., who concluded that the snowplow approach improves marginal adaptation and reduces the occurrence of interfacial defects in posterior composite restorations (20). Nevertheless, although the technique enhances adaptation, it does not fundamentally alter the magnitude of polymerization shrinkage stress. This may explain why microleakage values remained significantly higher than those observed in the SRDC groups.

The SRDC technique produced substantially lower microleakage scores compared with both Conventional and Snowplow restorations. The improved performance of SRDC can be explained by its emphasis on stress management during composite placement. The technique incorporates a thin flowable liner, oblique incremental layering, and sequential placement of composite against individual cavity walls rather than simultaneously bonding opposing walls. Such an approach effectively lowers the configuration factor (C-factor), thereby reducing the magnitude of polymerization shrinkage stress generated during curing (21). Furthermore, oblique layering decreases the volume of composite polymerized at one time, resulting in a more favorable stress distribution throughout the restoration. These findings are in agreement with the work of Deliperi and Alleman, who reported improved marginal integrity and reduced gap formation when stress-reduction protocols were employed during direct composite placement (22).

The SRDC + Fibre group demonstrated the lowest mean microleakage score among all experimental groups. The incorporation of polyethylene fibres may have contributed to this outcome through several mechanisms. Polyethylene fibres possess a high tensile strength and elastic modulus, allowing them to absorb and redistribute stresses generated during polymerization and functional loading (23). In addition, fibre reinforcement can act as a crack-arresting mechanism by interrupting crack propagation pathways within the composite restoration. The fibres may also contribute to improved stress transfer away from the adhesive interface, thereby reducing the likelihood of marginal gap formation (24). The significant difference observed between the SRDC and SRDC + Fibre groups suggests that fibre incorporation provided an additional benefit beyond stress reduction alone.

The progressive reduction in microleakage observed across the four groups supports the concept that both stress modification and structural reinforcement play important roles in achieving durable adhesive restorations. While Snowplow primarily improves adaptation, SRDC focuses on minimizing polymerization stresses through strategic placement of composite increments. The addition of polyethylene fibres appears to further enhance the restorative complex by reinforcing stress-bearing regions and improving resistance to interfacial failure.

The findings of the present study are clinically relevant because microleakage remains a major factor influencing the longevity of Class II composite restorations. Reduced microleakage may decrease bacterial penetration, postoperative sensitivity, marginal discoloration, and recurrent caries development (25). Consequently, restorative protocols that effectively control polymerization stress and improve marginal sealing may contribute to improved long-term clinical performance.

Certain limitations should be considered while interpreting these results. As an in vitro investigation, the study could not fully replicate the complex oral environment, including masticatory loading, salivary influences, pH fluctuations, and long-term thermal stresses. Additionally, dye penetration analysis provides a semi-quantitative assessment of leakage and may not precisely reflect clinical bacterial infiltration. Future studies employing micro-computed tomography, scanning electron microscopy, or long-term aging protocols may provide further insight into the effectiveness of stress-modifying restorative techniques.

Within the limitations of this study, the results suggest that the incorporation of stress-reduction strategies significantly improves marginal sealing in Class II composite restorations. Furthermore, the addition of polyethylene fibre reinforcement to the SRDC protocol appears to offer the greatest resistance to microleakage, indicating its potential value as an adjunctive restorative approach for improving restoration longevity.

REFERENCE

1. Davidson CL, Feilzer AJ. Polymerization shrinkage and polymerization shrinkage stress in polymer-based restoratives. J Dent. 1997;25(6):435–440.
2. Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymerization shrinkage stress in resin composites. Dent Mater. 2005;21(10):962–970.
3. Kidd EA. Microleakage: a review. J Dent. 1976;4(5):199–206.
4. An in vitro evaluation of microleakage in resin-based restorative materials at different time intervals. Bilgrami A, Alam MK, Qazi FU, Maqsood A, Basha S, Ahmed N, et al.Polymers (Basel). 2022;14(3):466. doi:10.3390/polym14030466
5. Pashley DH. Dentin bonding: overview of the substrate with respect to adhesive material. J Esthet Dent. 1991;3(2):46–50.
6. Feilzer AJ, De Gee AJ, Davidson CL. Setting stress in composite resin in relation to configuration of the restoration. J Dent Res. 1987;66(11):1636–1639.
7. Could marginal adaptation of composite resin restorations be influenced by a different polymer using different techniques? Pereira JR, Vermudt A, Raupp Junior A, Bordignon DS, Medeiros HV, Galvani LD, et al. Coatings. 2024;14(12):1618. doi:10.3390/coatings14121618
8. Ranjini MA, Geetha V, Vedavathi B, Ashok HK, Airsang AJ, Swathi S. Comparative evaluation of microleakage in Class II cavities restored with snowplow technique using flowable or preheated packable bulk fill composite resin as gingival increment by dye extraction method: An in vitro study. J Conserv Dent Endod 2024;27:1158 62.
9. Sharma N, Sapahiya S, Garg S, Sharma M Assessment of microleakage in class II cavities restored with composite resin by using different placement techniques. International Journal of Advanced Research in Medicine. 2022;4(2):118-121
10. Magne P., Composite Resins and Bonded Porcelain: The Postamalgam Era?, Journal of the California Dental Association. (2006) 34, no. 2, 135–147
11. Deliperi S. and Bardwell D. N., An Alternative Method to Reduce Polymerization Shrinkage in Direct Posterior Composite Restorations, The Journal of the American Dental Association. (2002) 133, no. 10, 1387–1398, 2-s2.0-0036777216.
12. Tavangar, Seyedeh Maryam, Davalloo, Reza Tayefeh, Darabi, Farideh, Tajziehchi, Gelareh, Stress Distribution Pattern in Class I Cavities Restored by Different Techniques According to the Stress Reducing Direct Composite Concept: A Finite Element Analysis, International Journal of Dentistry, 2025, 7196931, 15 pages, 2025.

https://doi.org/10.1155/ijod/7196931
13. Paul A, Dubey R, Joshi SB, Patil AC, Narvekar PS. Fracture resistance of postendodontic restoration using self-adhesive bioactive resin and a bulk-fill composite with or without resin-impregnated glass fibers: An in vitro study. J Conserv Dent Endod. 2024 Sep;27(9):908-912. doi: 10.4103/JCDE.JCDE_428_24. Epub 2024 Sep 7. PMID: 39450359; PMCID: PMC11498243.
14. Deliperi S, Alleman D, Rudo D.
Stress-reduced direct composites for the restoration of structurally compromised teeth: fiber design according to the "wallpapering" technique.Oper Dent. 2017;42(3):233–243. doi:10.2341/15-289-T
15. Ferracane JL. Developing a more complete understanding of stresses produced in dental composites during polymerization. Dent Mater. 2005;21(1):36–42.
16. Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymerization shrinkage stress in resin composites. Dent Mater. 2005;21(10):962–70.
17. Feilzer AJ, De Gee AJ, Davidson CL. Setting stress in composite resin in relation to configuration of the restoration. J Dent Res. 1987;66(11):1636–9.
18. Loguercio AD, Reis A, Ballester RY. Polymerization shrinkage: effects on microleakage and marginal adaptation of composite restorations. Oper Dent. 2004;29(4):398–404.
19. Abbas G, Fleming GJ, Harrington E, Burke FJT. Cuspal movement and microleakage in premolar teeth restored with a novel snowplow technique. J Dent. 2003;31(5):341–6.
20. Chuang SF, Jin YT, Liu JK, Chang CH, Shieh DB. Influence of flowable composite lining thickness on Class II composite restorations. Oper Dent. 2004;29(3):301–8.
21. Nikolaenko SA, Lohbauer U, Roggendorf MJ, Petschelt A, Dasch W, Frankenberger R. Influence of C-factor and layering technique on microleakage of Class II composite restorations. Dent Mater. 2004;20(6):579–85.
22. Deliperi S, Alleman D. Stress-reduced direct composites for the restoration of structurally compromised teeth. Pract Proced Aesthet Dent. 2002;14(6):439–46.
23. Garoushi S, Vallittu PK, Lassila LVJ. Short glass fiber reinforced restorative composite resin with semi-interpenetrating polymer network matrix. Dent Mater. 2007;23(11):1356–62.
24. Rudo DN, Karbhari VM. Physical behaviors of fiber reinforcement as applied to tooth stabilization. Dent Clin North Am. 1999;43(1):7–35.
25. Kidd EAM. Microleakage: a review. J Dent. 1976;4(5):199–206.