ORIGINAL ARTICLE

Comparative Evaluation of Post-operative Sensitivity between Light-Cure and Dual-Cure Composites in Open and Closed Sandwich Bilayer Restorations

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Abstract

Background: Post-operative sensitivity is a major worry after composite restorations because of polymerization shrinkage stress at the dentin–resin interface. Both open and closed sandwich techniques and different composite curing modes have been proposed to contain these effects. However, there are limited direct clinical comparisons between light-cure and dual-cure composites in these configurations. **Objective:** This study aimed to compare posterior composite restorations as dentin substitutes within open and closed sandwich techniques using light-cure and dual-cure composites and to assess post-operative sensitivity. **Materials and Methods:** A total of 67 patients were involved in this randomized double-blind clinical trial, contributing 205 posterior teeth. The teeth were divided into four groups based on the technique used: Light-cure or dual-cure composite placed with either an open or closed sandwich technique. Post-operative sensitivity was evaluated subjectively and objectively using cold testing at baseline and at 1, 3, 6, 9, and 12 months post-restoration. The data were analyzed using Chi-square and Fisher's exact tests. The level of significance was kept at $P < 0.05$. **Results:** All groups showed a significant reduction in sensitivity from baseline to the first follow-up. At 12 months, the light-cure composite in the closed sandwich group demonstrated slightly better outcomes (82.4% sensitivity-free) than the open sandwich group (76.5%). For dual-cure composites, the open sandwich group was marginally better at 72.2% than the closed group at 66.7%. However, none of these differences was statistically significant ($P > 0.05$). **Conclusion:** Both the composite types and techniques gave low post-operative sensitivity for over 12 months. Slight trends favor the light-cure composites in closed techniques and the dual-cure composites in open techniques. This would provide clinical flexibility, especially when supported by strict operative protocols.

Key words: Bilayer restoration, clinical trial, dual-cure composite, light-cure composite, polymerization shrinkage, Post-operative sensitivity, sandwich technique

INTRODUCTION

One of the constant problems in restorative dentistry is trying to counteract the negative effects of polymerization shrinkage of resin-based composites, particularly at the tooth-restoration interface.[1-3] Polymerization contraction forces can compromise marginal integrity because they create microgaps through which bacteria can leak, leading to developed caries and, most importantly, post-operative sensitivity. These outcomes not only affect the clinical success of the restoration but also the comfort of the patient and the prognosis of the restoration in the long term.

To counteract these effects, different strategies have been proposed. One approach is to use dentin bonding agents that can achieve immediate bond strengths higher than the internal stresses developed during polymerization.[4] A second approach is to use cavity liners of intermediate elastic

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moduli that act as stress-absorbing buffers at the dentin–resin interface junction.[5] The incremental layering technique is another aspect that has gained widespread acceptance in controlling the volume of composite cured at one time so as to reduce the overall magnitude of shrinkage stress.[6,7]

The bilayer restoration technique has recently been developed to manage polymerization vectors and reduce interfacial stress.[8] The proximal box or gingival floor is restored first with chemically or dual-cured composite, and then, a light-cured composite is placed in the occlusal segment.[8,9] Some adhesive systems can initiate polymerization at the adhesive interface; therefore, the vector of shrinkage is directed towards bonded dentin to improve marginal adaptation. The rationale behind this technique is that some adhesive systems may initiate polymerization at the adhesive interface, thereby directing the vector of shrinkage toward the bonded dentin. This is supposed to improve marginal adaptation.[10] It gives more control over the working time, surface finish, and esthetics while placing light-cured composite in the occlusal part.[11]

The sandwich technique comes in two primary variations – closed and open.[8] In the closed sandwich technique, the liner, usually a conventional or resin-modified glass ionomer cement (GIC) or chemically cured composite, is applied to the pulpal floor and axial wall and totally enclosed within the overlying composite.[12] On the other hand, the open sandwich technique has the liner placed along the pulpal floor, axial wall, and gingival seat, so it stays partly exposed to the oral environment.[13] This may help improve marginal sealing, especially in deeper cervical restorations.

Flowable composites, resin-modified and conventional GICs,[14,15] resin fiber inserts,[16,17] pre-polymerized composite inserts, mineral trioxide aggregate,[18] and novel expanding monomers such as spiro-orthocarbonates that polymerize through a double ring-opening mechanism to counteract volumetric shrinkage. In another application, these liners could flow under pressure and bear the load of the cement until it sets.[19,20]

Many clinical studies have been done on post-operative sensitivity with light-cured composite restorations,[21,22] but there is limited clinical information on the performance of dual-cure composites as dentin substitutes in bilayer restorations. Even fewer studies have compared post-operative sensitivity outcomes between the open and closed sandwich techniques using dual-cure and light-cure composites.

Hence, this randomized clinical trial aimed to compare post-operative sensitivity of posterior composite restorations using dual-cure and light-cure composites as substitutes for dentin, applied with open and closed sandwich techniques, over 12 months.

MATERIALS AND METHODS

Ethical approval and trial registration

This study was approved by the Institutional Review Board of Saveetha University (IRB Ref No: 010) and by the Institutional Ethical Committee (IEHC No: MDS 77/SU120/2011). The registration is with Clinical Trials Registry–India (CTRI Ref No: 003655).

Study design and participants

This double-blind, randomized controlled clinical trial was conducted in the Department of Conservative Dentistry and Endodontics at Saveetha Dental College. After obtaining written informed consent, 67 patients aged 18–50 years with carious lesions in the anterior and posterior teeth were included. The inclusion criteria involved vital teeth with shallow to moderately deep Class I, II, III, or IV carious lesions without pulpal involvement, based on clinical and radiographic assessment. An additional requirement was that each patient had one tooth free from caries that could be used as a control reference. Teeth were excluded if they had deep lesions requiring liners or bases, presented with pre-operative pain, showed signs of attrition, or had failed restorations. The CONSORT flow diagram showing the selection and allocation of the participants is shown in [Figure 1].

Randomization and blinding

The 205 teeth were allocated using block randomization into two primary groups based on restorative technique: the closed sandwich group and the open sandwich group. These were further subdivided according to the type of composite material used. Only the principal investigator (operator) was unblinded with respect to group allocation; patients and the co-investigator (evaluator) were kept masked from knowing the treatment assignments.

Materials used

The restorative materials used were light-cured composite resin (Ceram-X, Dentsply) and dual-cure composite resin (Multicore Flow, IvoclarVivadent). Cavity conditioning was done using 35% phosphoric acid etchant (Ivoclar). An acetone-based bonding agent (Prime and Bond NT, Dentsply) was applied before the composite was placed. Polishing was done with the Optrapol composite finishing kit (IvoclarVivadent). Thermal sensitivity testing was carried out using ice sticks kept at 8 ± 1°C.

Baseline sensitivity assessment

For each patient, the baseline sensitivity of the reference tooth was recorded before the restorative procedures.

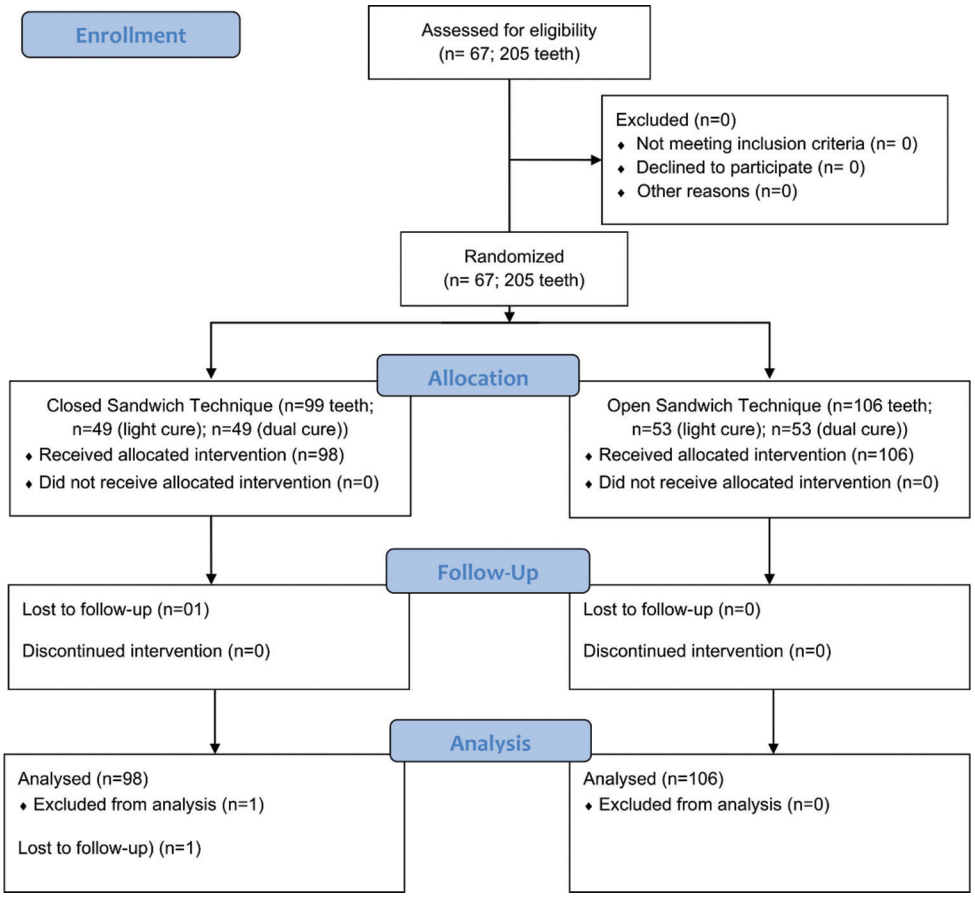

Figure 1: Consort flow diagram

Subjective sensitivity was assessed using a verbal numeric pain score. Where 0 = no pain, 1 = mild, 2 = moderate, and 3 = severe pain. Objective sensitivity was tested by an ice stick at the occlusal and middle third of the buccal surface of the tooth. The response was graded as mild, moderate, or severe. The same was done for the experimental teeth before restoration.

Tooth preparation and restorative procedures

All procedures were carried out under rubber dam isolation. Carious tissue was removed using high-speed diamond burs under water coolant. Cavity conditioning was done with 35% phosphoric acid for 15 s, followed by rinsing and then gentle drying with air to avoid desiccation. After that, the bonding agent was applied and light-cured for 20 s.

In the closed sandwich technique, applied to Class I and III cavities, the control subgroup received light-cure composite (Tetric Ceram, IvoclarVivadent) incrementally placed in the entire cavity, each increment being light-cured for 40 s. In the experimental subgroup, dual-cure composite (Multicore Flow) was placed in the gingival two-thirds of the cavity; it was allowed to chemically cure for 4 min, and then light curing was done for 40 s. The coronal third of the cavity was restored using light-cure composite. During its placement, the operatory light was turned off to prevent premature polymerization.

In the open sandwich technique, applied to Class II and IV cavities, the control subgroup was treated using a Tofflemire matrix for cavity contouring and restored with light-cure composite placed incrementally – each increment cured for 40 s. In the experimental subgroup, the matrix band was adapted around the tooth, and dual-cure composite was placed in bulk to fill the gingival two-thirds of the cavity, including the axial wall and gingival cavosurface margins. After 4 min of chemical setting, light curing was carried out for 40 s. The coronal portion was subsequently restored using light-cure composite.

Finishing, polishing, and follow-up

After restoration, occlusal adjustments were made if necessary. All restorations were finished and polished using composite finishing burs and the Optrapol system. Patients were recalled at 1, 3, 6, 9, and 12 months for follow-up evaluations. Sensitivity was evaluated at each recall visit using the same subjective and objective criteria applied at baseline.

Statistical analysis

Data were compiled using Microsoft Excel and analyzed with the Statistical Package for the Social Sciences software (version 22; IBM Corp., Armonk, NY, USA). A sample size of 88 teeth for each comparison group was required to detect a 15% difference in post-operative sensitivity with 80% power at a significance level of 0.05. A total of 205 teeth were used in this study to cover all four groups and allow for possible dropouts. Descriptive statistics, such as sensitivity scores at different follow-up intervals, were summarized using frequencies and percentages for categorical variables. The Chi-square test or Fisher's exact test was used, as appropriate, to compare the post-operative sensitivity between the groups (closed vs. open sandwich) and the restorative materials (light cure vs. dual cure composite). $P < 0.05$ was considered significant. Sensitivity outcomes at baseline and during follow-up (1, 3, 6, 9, and 12 months) were classified as mild (Grade 1), moderate (Grade 2), or severe (Grade 3) and the distribution of these outcomes was compared across the study groups.

RESULTS

A total of 67 patients participated in the study, with a contribution of 205 teeth. Ninety-eight teeth were restored with the closed sandwich technique (Group 1) and 106 teeth with the open sandwich technique (Group 2). There was one patient who was lost to follow-up.

Baseline sensitivity assessment

Baseline sensitivity was assessed using a verbal numeric pain scale and thermal response testing with ice sticks. In the subgroup restored using light-cure composite, the open sandwich group showed slightly higher incidence of moderate-to-severe sensitivity at baseline than the closed sandwich group, but this difference was not statistically significant. In the dual-cure composite subgroup, however, the closed sandwich group showed a significantly different distribution of baseline sensitivity scores compared to the open sandwich group ($P = 0.012$; Table 1).

Post-operative sensitivity: Follow-up evaluations

Sensitivity was reassessed at each follow-up interval (1, 3, 6, 9, and 12 months) postoperatively using the same clinical and thermal response criteria. All groups showed a progressive loss of sensitivity with time, irrespective of the composite material or technique used.

Comparison between closed and open sandwich techniques (dual cure composite)

In the dual-cure composite subgroup, the post-operative sensitivity scores were slightly better with the open sandwich technique over the entire follow-up period. Although the baseline sensitivity distribution showed a statistically significant difference between the two groups ($P = 0.012$), the differences observed at subsequent intervals were

Table 1: Sensitivity comparison between open and closed techniques in the dual-cure composite group

Intervention time	Sensitivity grade	Open sandwich (%)	Closed sandwich (%)	*P*-value
Base line	1	14 (31.1)	3 (6.7)	0.012
	2	24 (53.3)	34 (75.6)	
	3	7 (15.6)	8 (17.8)	
1 month	1	34 (79.1)	33 (76.7)	0.792
	2	8 (18.6)	10 (23.3)	
	3	1 (2.3)	0 (0.0)	
3 months	1	30 (69.8)	36 (83.7)	0.314
	2	10 (23.3)	6 (14.0)	
	3	3 (7.0)	1 (2.3)	
6 months	1	29 (67.4)	36 (87.8)	0.059
	2	12 (27.9)	4 (9.8)	
	3	2 (4.7)	1 (2.4)	
9 months	1	28 (65.1)	30 (73.2)	0.561
	2	13 (30.2)	4 (19.5)	
	3	2 (4.7)	1 (7.3)	
12 months	1	4 (66.7)	13 (72.2)	0.999
	2	2 (33.3)	1 (27.8)	

not statistically significant ($P > 0.05$). These findings are summarized in Table 1.

Comparison between closed and open sandwich techniques (light-cure composite)

In the light-cure composite subgroup, sensitivity outcomes were marginally better with the closed sandwich technique than with the open sandwich technique. At each follow-up visit, a higher percentage of teeth in the closed sandwich group reported no or mild sensitivity. However, these differences did not reach statistical significance ($P > 0.05$). A detailed comparison is presented in Table 2.

Comparison within dual-cure composite restorations

The open sandwich technique with dual-cure composite showed better post-operative sensitivity outcomes than the closed sandwich technique. At baseline, the closed sandwich group had more cases of moderate sensitivity than the open sandwich group ($P = 0.012$). Over the course of the follow-up period, both groups showed clinical improvement, with the open sandwich group maintaining slightly better sensitivity scores. However, these differences were not statistically significant at the follow-up intervals ($P > 0.05$; Table 3).

Comparison of composite materials within the closed sandwich technique

In the closed sandwich technique, teeth restored with light-cure composite showed slightly better sensitivity outcomes at each follow-up time point. A greater proportion of teeth in the light-cure subgroup consistently reported no or only mild sensitivity. None of the comparisons reached statistical significance ($P > 0.05$) in Table 3. Although the trend was not significant, a trend toward lower sensitivity for the light-cure composite was observed. No comparisons reached statistical significance, as shown in Table 4.

Comparison of composite materials within the open sandwich technique

In the open sandwich group, dual-cure composite showed a slight clinical superiority over light-cure composite in reducing post-operative sensitivity. At 3, 6, and 9 months, more teeth in the dual-cure subgroup reported no sensitivity compared to those in the light-cure subgroup. However, these differences were statistically not significant ($P > 0.05$). The results are detailed in Table 5.

DISCUSSION

Post-operative sensitivity is still a major concern after composite resin restorations; most commonly, it is attributed

Table 2: Sensitivity comparison between open and closed techniques in the light-cure composite group

Intervention time	Sensitivity grade	Open sandwich (%)	Closed sandwich (%)	*P*-value
Base line	0	2 (3.9)	0 (0.0)	0.051
	1	7 (13.7)	5 (10.2)	
	2	35 (68.6)	27 (55.1)	
	3	7 (13.7)	17 (34.7)	
1 month	1	38 (76.0)	33 (78.6)	0.609
	2	12 (24.0	8 (19.0)	
	3	0 (0.0)	1 (2.4)	
3 months	1	38 (77.6)	33 (78.6)	0.606
	2	11 (22.4)	8 (19.0)	
	3	0 (0.0)	1 (2.4)	
6 months	1	38 (77.6)	32 (76.2)	0.792
	2	11 (22.4)	9 (21.4)	
	3	0 (0.0)	1 (2.4)	
9 months	1	34 (69.4	32 (76.2)	0.495
	2	14 (28.6)	8 (19.0)	
	3	1 (2.0)	2 (4.8)	
12 months	1	14 (82.4)	13 (76.5)	0.999
	2	2 (11.8)	3 (17.6)	
	3	1 (5.9)	2 (5.9)	

Table 3: Sensitivity comparison between open and closed techniques in the dual-cure composite group

Intervention time	Sensitivity grade	Open sandwich (%)	Closed sandwich (%)	*P*-value
Base line	1	14 (31.1)	3 (6.7)	0.012
	2	24 (53.3)	34 (75.6)	
	3	7 (15.6)	8 (17.8)	
1 month	1	34 (79.1)	33 (76.7)	0.792
	2	8 (18.6	10 (23.3)	
	3	1 (2.3)	0 (0.0)	
3 months	1	30 (69.8)	36 (83.7	0.314
	2	10 (23.3)	6 (14.0)	
	3	3 (7.0)	1 (2.3	
6 months	1	29 (67.4)	36 (87.8)	0.059
	2	12 (27.9)	4 (9.8)	
	3	2 (4.7)	1 (2.4)	
9 months	1	28 (65.1)	30 (73.2)	0.561
	2	13 (30.2)	4 (19.5)	
	3	2 (4.7)	1 (7.3)	
12 months	1	4 (66.7)	13 (72.2)	0.999
	2	2 (33.3)	1 (27.8)	

Table 4: Sensitivity comparison between light cure and dual cure group in the closed sandwich group

Intervention time	Sensitivity grade	Light cure (%)	Dual cure (%)	*P*-value
Base line	0	2 (3.9)	0 (0.0)	0.099
	1	7 (13.7)	14 (31.1)	
	2	35 (68.6)	24 (53.3)	
	3	7 (13.7)	7 (15.6)	
1 month	1	38 (76.0)	34 (79.1)	0.531
	2	12 (24.0)	8 (18.6)	
	3	0 (0.0)	1 (2.3)	
3 months	1	38 (77.6)	30 (69.8)	0.206
	2	11 (22.4)	10 (23.3)	
	3	0 (0.0)	3 (7.0)	
6 months	1	38 (77.6)	29 (67.4)	0.241
	2	11 (22.4)	12 (27.9)	
	3	0 (0.0)	2 (4.7)	
9 months	1	34 (69.4)	28 (65.1)	0.794
	2	14 (28.6)	13 (30.2)	
	3	1 (2.0)	2 (4.7)	
12 months	1	14 (82.4	4 (66.7)	0.477
	2	2 (11.8)	2 (33.3	
	3	1 (5.9	0 (0.0	

to the polymerization shrinkage stresses at the interface of the adhesive. Such stresses may lead to the formation of marginal gaps, microleakage, and bacterial penetration, which may end in discomfort and reduced longevity of the restoration.[4] The current double-blind randomized controlled study was designed to investigate the influence of the technique of

Table 5: Sensitivity comparison between Light cure and Dual cure group in the open sandwich group

Follow-up time	Sensitivity grade	Light-cure composite (%)	Dual-cure composite (%)	Total (%)	*P*-value
Base line	1	5 (10.2)	3 (6.7)	8 (8.5)	0.121
	2	27 (55.1)	34 (75.6)	61 (64.9	
	3	17 (34.7)	8 (17.8)	25 (26.6)	
1 month	1	33 (78.6)	33 (76.7)	66 (77.6)	0.792
	2	8 (19.0)	10 (23.3)	18 (21.2)	
	3	1 (2.4)	0 (0.0)	1 (1.2)	
3 months	1	33 (78.6)	36 (83.7)	69 (81.2)	0.782
	2	8 (19.0)	6 (14.0)	14 (16.5)	
	3	1 (2.4)	1 (2.3)	2 (2.4)	
6 months	1	32 (76.2)	36 (87.8)	68 (81.9)	0.342
	2	9 (21.4)	4 (9.8)	13 (15.7)	
	3	1 (2.4)	1 (2.4)	2 (2.4)	
9 months	1	32 (76.2)	30 (73.2)	62 (74.7)	0.929
	2	8 (19.0)	8 (19.5)	16 (19.3)	
	3	1 (4.8)	1 (7.3	5 (6.0)	
12 months	1	13 (76.5)	13 (72.2)	26 (74.3)	0.696
	2	3 (17.6)	5 (27.8)	8 (22.9)	
	3	1 (5.9)	0 (0.0)	1 (2.9)	

restoration (open vs. closed sandwich) and composite type (light-cure vs. dual-cure) on post-operative sensitivity over a 12-month period.

In their use, light-cure composites exhibit rapid polymerization, which restricts the flow of resin and may therefore increase internal stress.[23] Dual-cure composites polymerize more slowly, thereby allowing better stress relief due to increased flow of resin.[24] However, as in the studies of Perdigao *et al*. (2004) and Loguercio *et al*., there was no statistically significant advantage of dual-cure over light-cure composites in terms of sensitivity reduction according to our findings.[25,26] These results seem to imply that material chemistry alone cannot adequately counteract stress-induced sensitivity.

Cavity geometry and bonding approach also affect polymerization shrinkage. Although the initial theories were based on the direction of light, Versluis *et al*. proved that it was the configuration factor (C-factor), which was bonded to unbonded surfaces, that determined stress distribution.[27] High C-factors, high internal stress, and microleakage go together.[28] The sandwich techniques in this study, by their nature, expose different C-factors; the open sandwich has an additional unbonded surface that may help dissipate stress.

The techniques with open and closed sandwich groups showed no statistically significant difference in sensitivity, irrespective of the type of composite. However, trends within the groups indicated that light-cure composites were slightly better in the closed sandwich technique [Table 3] and dual-cure composites were marginally better in the open sandwich technique [Table 4]. The present findings go hand in hand with earlier results by Van Dijken (1999) and Fabianelli *et al*., who had emphasized results depending on the technique. Our cavity designs were based on the saucer-shaped geometry recommended by other studies; this would have made an additional contribution to lower marginal stress.[29,30] Margin stress is very much influenced by the geometry of the cavity, so due precautions were taken to ensure the same saucer-shaped cavity for all samples.[16,27]

Sensitivity scores showed a constant decrease throughout the follow-up period, representing the typical trajectory of desensitization, as observed in other studies. While there was a statistically significant decrease from baseline, the difference between successive follow-up intervals was not significant, indicating a slow adaptation rather than sudden recovery.

Sensitivity assessment combined subjective self-reports with objective thermal testing using ice sticks. As observed in earlier studies, objective tests tended to detect higher sensitivity levels than patient-reported scores.[31] Cold stimuli were consistently the most effective in eliciting sensitivity, reinforcing the utility of ice stick testing in clinical trials.[31]

These valuable insights are limited by a few considerations. The modest sample size of the study, though adequate for preliminary conclusions, may have limited statistical power to detect small intergroup differences. The study also introduced some heterogeneity by including multiple

cavity classes. Operator blinding was not possible, which could also introduce performance bias. Material systems were from different manufacturers, so that they could have introduced confounding factors irrelevant to curing mode. Finally, a 12-month follow-up, though adequate for short-term outcomes, does not reflect long-term sensitivity or restoration success.

In general, the findings reveal that both light-cure and dual-cure composite restorations, when placed using either open or closed sandwich techniques with sound clinical protocols, have low and decreasing post-operative sensitivity. Although no one method was statistically better than the others, the selection of materials and optimization of techniques can be based on cavity configuration and clinical judgment to improve patient comfort and reduce complications.

CONCLUSION

This randomized controlled clinical trial revealed that both the open and closed sandwich techniques provided low post-operative sensitivity over 12 months. Although light-cure composites showed a trend for better results in the closed sandwich technique and dual-cure composites in the open sandwich technique, the difference was not statistically significant. In general, both material types and techniques showed similar clinical results when proper operative protocols were used. More substantial long-term studies are required to confirm these results.

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REFERENCES

1. Soares CJ, Faria-E-Silva AL, De Rodrigues MP, Vilela AB, Pfeifer CS, Tantbirojn D, *et al*. Polymerization shrinkage stress of composite resins and resin cements - what do we need to know? Braz Oral Res 2017;31 Suppl 1:e62.
2. Gallo M, Abouelleil H, Chenal JM, Adrien J, Lachambre J, Colon P, *et al*. Polymerization shrinkage of resin-based composites for dental restorations: A digital volume correlation study. Dent Mater 2019;35:1654-64.
3. Pereira JR, Júnior LC, Só MV, Júnior NF. Effect of thermocycling and varying polymerization techniques on the restorative interface of class V cavities restored with different composite resin systems. J Clin Exp Dent 2017;9:e405-9.
4. Schneider LF, Cavalcante LM, Silikas N. Shrinkage stresses generated during resin-composite applications: A review. J Dent Biomech 2010;2010:131630.
5. Oglakci B, Kazak M, Donmez N, Dalkilic EE, Koymen SS. The use of a liner under different bulk-fill resin composites: 3D GAP formation analysis by x-ray microcomputed tomography. J Appl Oral Sci 2020;28:e20190042.
6. Choi KK, Condon JR, Ferracane JL. The effects of adhesive thickness on polymerization contraction stress of composite. J Dent Res 2000;79:812-7.
7. Chandrasekhar V, Rudrapati L, Badami V, Tummala M. Incremental techniques in direct composite restoration. J Conserv Dent 2017;20:386-91.
8. Kadhi H, Winnier J. Sandwich technique in primary teeth: A review. J Res Dent Maxillofac Sci 2022;7:267-72.
9. Croll TP. The "sandwich" technique. J Esthet Restor Dent 2004;16:210-2.
10. Imai Y, Kadoma Y, Kojima K, Akimoto T, Ikakura K, Ohta T. Importance of polymerization initiator systems and interfacial initiation of polymerization in adhesive bonding of resin to dentin. J Dent Res 1991;70:1088-91.
11. Fusayama T. Indications for self-cured and light-cured adhesive composite resins. J Prosthet Dent 1992;67:46-51.
12. Andersson-Wenckert IE, Van Dijken JW, Hörstedt P. Modified class II open sandwich restorations: Evaluation of interfacial adaptation and influence of different restorative techniques. Eur J Oral Sci 2002;110:270-5.
13. Loguercio AD, Alessandra R, Mazzocco KC, Dias AL, Busato AL, Da Singer JM, *et al*. Microleakage in class II composite resin restorations: Total bonding and open sandwich technique. J Adhes Dent 2002;4:137-44.
14. Shinde MM, Kamat SB. Influence of flowable composite liner on the microleakage of posterior packable resin composites - an *in vitro* study. IP Indian J Conserv Endod 2018;3:19-22.
15. Sampaio P, De Almeida Júnior A, Francisconi L, Casas-Apayco L, Pereira J, Wang L, *et al*. Effect of conventional and resin-modified glass-ionomer liner on dentin adhesive interface of class I cavity walls after thermocycling. Oper Dent 2011;36:403-13.
16. Dhingra V, Taneja S, Kumar M, Kumari M. Influence of fiber inserts, type of composite, and gingival margin location on the microleakage in Class II resin composite restorations. Oper Dent 2014;39:E9-15.
17. Applequist EA, Meiers JC. Effect of bulk insertion, prepolymerized resin composite balls, and beta-quartz inserts on microleakage of Class V resin composite restorations. Quintessence Int 1996;27:253-8.
18. Parirokh M, Torabinejad M, Dummer PM. Mineral trioxide aggregate and other bioactive endodontic cements: An updated overview - part I: Vital pulp therapy. Int Endod J 2018;51:177-205.
19. He J, Lassila L, Garoushi S, Vallittu P. Tailoring the monomers to overcome the shortcomings of current

dental resin composites - review. Biomater Investig Dent 2023;10:2191621.
20. Mousavinasab SM. Biocompatibility of composite resins. Dent Res J (Isfahan) 2011;8 Suppl 1:S21-9.
21. Maghaireh GA, Albashaireh ZS, Allouz HA. Postoperative sensitivity in posterior restorations restored with self-adhesive and conventional bulk-fill resin composites: A randomized clinical split-mouth trial. J Dent 2023;137:104655.
22. Umer F, Khan FR. Postoperative sensitivity in Class V composite restorations: Comparing soft start vs. Constant curing modes of LED. J Conserv Dent JCD 2011;14:76-9.
23. Carvalho AA, Moreira Fdo CL, Fonseca RB, Soares CJ, Franco EB, Souza JB, *et al*. Effect of light sources and curing mode techniques on sorption, solubility and biaxial flexural strength of a composite resin. J Appl Oral Sci Rev FOB 2012;20:246-52.
24. Wang R, Liu H, Wang Y. Different depth-related polymerization kinetics of dual-cure, bulk-fill composites. Dent Mater 2019;35:1095-103.
25. Loguercio AD, Carpio-Salvatierra B, Ñaupari-Villasante R, Wendlinger M, Armas-Vega A, Cavagnaro S, *et al*. Clinical evaluation of a new chemically-cured bulk-fill composite in posterior restorations: 6-month multicenter double-blind randomized clinical trial. J Dent 2024;149:105246.
26. Perdigão J, Anauate-Netto C, Carmo AR, Hodges JS, Cordeiro HJ, Lewgoy HR, *et al*. The effect of adhesive and flowable composite on postoperative sensitivity: 2-week results. Quintessence Int 2004;35:777-84.
27. Versluis A, Tantbirojn D, Douglas WH. Do dental composites always shrink toward the light? J Dent Res 1998;77:1435-45.
28. Da Silva EM, Dos Santos GO, Guimarães JG, Barcellos AA, Sampaio EM. The influence of c-factor, flexural modulus and viscous flow on gap formation in resin composite restorations. Oper Dent 2007;32:356-62.
29. Van Dijken JW, Kieri C, Carlén M. Longevity of extensive class II open-sandwich restorations with a resin-modified glass-ionomer cement. J Dent Res 1999;78:1319-25.
30. Fabianelli A, Sgarra A, Goracci C, Cantoro A, Pollington S, Ferrari M. Microleakage in class II restorations: Open vs closed centripetal build-up technique. Oper Dent 2010;35:308-13.
31. Auschill TM, Koch CA, Wolkewitz M, Hellwig E, Arweiler NB. Occurrence and causing stimuli of postoperative sensitivity in composite restorations. Oper Dent 2009;34:3-10.

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