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Comparative Evaluation of Microleakage in Class II Cavities Restored with Snow Plow Technique Using Different Flowable Composite Resins as Gingival Increment Followed by Packable Composite Resin Restorations – An In-Vitro Dye Extraction Study

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Abstract

To evaluate and compare microleakage in class II cavities restored with snow plow technique using two different flowable composite resins as gingival increment followed by packable composite resin restorations. Fifty sound first molars free of caries, cracks, decay and restorations were selected for this study. Class II mesio occlusal box preparations were made with the following dimensions, buccolingually-3mm, mesiodistally-2mm. The gingival margin was placed 1mm above CEJ. The test specimens were randomly divided into two groups for restoration. GROUP 1: Tetric N Flow bulk fill and Tetric N Ceram bulk fill co cured in snow plow technique. Group 2: SDR plus bulk fill and Tetric N Ceram bulk fill co cured in snow plow technique. Restored teeth were thermocycled for 500 cycles between 5° C and 55° C. The radicular apices of teeth were sealed the teeth were covered with nail varnish completely, except for 1-2 mm around the margins of restorations. The samples were immersed in 2% methylene blue dye for 24 hours, washed and processed for dye extraction. Sample absorbance value was read by UV visible spectrophotometer at 550 nm. Statistical analysis was done using SPSS software and Mann-Whitney U test. Results showed lower microleakage in SDR plus group (median of 0.0398) compared to Tetric N flow bulk fill group (median of 0.05890) and the difference between them was statistically significant. The present study concluded that SDR plus bulk fill restoration of class II cavities in snow plow technique showed lower microleakage compared to Tetric N flow bulk fill composite resin in snow plow technique.

KEYWORDS

Snow plow, SDR plus, Bulk fill, Microleakage, Dye extraction

1 | INTRODUCTION

Dental composite resins have advanced tremendously to become the most preferred material for direct restorations in both anterior and pos-terior teeth. The restoration of natural contour of tooth, proximal con-tacts as well as sealing of the margins is of critical importance. Despite having good physical and mechanical properties, the main reason for failure of these restorations is the recurrence of caries. Achieving a com-plete and durable marginal seal in direct composite resin restorations, particularly in class II cavities still poses a challenge.[1] Polymerization shrinkage associated with these materials generates stresses that can damage the bond of the resin composites to the cavity walls, which produces microleakage allowing bacteria and fluids to move via the tooth-restoration interface.[2] This marginal microleakage can produce recurrent caries, hypersensitivity, discolorations, and pulpal lesions, among others.[3]

Polymerization shrinkage in composite resin is governed by vari-ous factors, some of which are under the manufacturer's control while others are under the clinician's control. Factors under manufacturers control include type and amount of resin matrix, type and amount of the filler and photo activator system used. Factors under clinicians control include using various techniques such as different incremental place-ment techniques, using low modulus of elasticity material as the first increment, placing thicker adhesive layers under composites, using fiber inserts and use of various light curing methods such as ramp curing and pulse curing.[4]

One of the most important factors in the reduction in shrinkage stresses in class II cavities, is the restoration placement techniques. Although incremental technique may be important for adequate light penetration, its disadvantages are the possibility of trapping voids between layers and the formation of oxygen inhibition layer at the sur-face of the cured layer. Among the placement techniques, application of resin composite in bulk increments of up to 4mm has the advan-tages of reduced treatment time by reducing the number of increments, enhanced depth of cure owing to the addition of specialized fillers and photo initiators, and reduction in the number of voids.[5]

The recently developed bulk Fill composite resins possess spe-cific characteristics, enabling them to adapt efficiently to the cavity preparation.[6] However in deep class II preparations, marginal adapta-tion and flow is questionable even with bulk fill resins. To overcome these challenges in class II cavity restorations, snow plow technique was introduced, in which a less viscous material is applied as gingival incre-ment, overlayed by packable bulk fill composite resin and both materials together are co cured.[7] Subsequently, rest of the preparation is com-pleted with packable bulk fill composite resin. This technique has the advantages that the more viscous superficial composite helps in bet-ter flow and adaptation of flowable material, better bonding to unset subsequent increment and allows the flowable material to behave as a stress absorber.[8]

SDR plus bulk fill composite resin was developed with a Stress Decreasing Resin (SDR™) technology. It enables bulk-fill up to 4mm instead of placing and curing multiple composite layers in Class I and II restorations. It is indicated to be overlayed with a methacrylate-based universal composite for replacing missing occlusal/facial enamel.

The SDR technology is a patented urethane Di methacrylate structure that is responsible for the reduction in polymerization shrinkage and stress.[9] SDR has minimal overall shrinkage 3.5% compared to other con-ventional flowable composites. Lower volumetric shrinkage contributes to overall lower polymerization stress. It also exhibits self levelling technology that promotes excellent cavity adaptation.[10]

Tetric N-Ceram Bulk Fill and Tetric N-Flow Bulk Fill can be applied in "bulk" increments of up to 4 mm as they contain the new light initia-tor called Ivocerin.[11] As a result of its higher photo-reactivity compared with the initiators contained in other bulk-fill materials, the opacity of the composite resin is also slightly higher. Hence, polymerization is initi-ated even in very deep cavities and the material is fully cured. It contains an isofiller, a specially conditioned shrinkage stress reliever with a low modulus of elasticity that attenuates the forces generated during shrink-age and thereby keeps shrinkage and stress during polymerization to a minimum.[12]

The curing shrinkage and its associated stress may be greater for a flowable composite, due to the typically lower filler content, and pre-curing of this liner produces stresses that may compromise its adap-tation and sealing of the margins. The composite placement technique in snow plow method ensures that the flowable material is "pushed" into a highly thin layer that is simultaneously cured with the conventional composite, the negative effects of shrinkage of a relatively thick layer of flowable is potentially negated.

A search on literature is limited regarding evaluation of microleak-age in class 2 cavities restored with SDR plus bulk fill and Tetric N flow bulk fill composite resin as initial increment in snow plow technique. Hence the current study evaluated microleakage in class 2 prepara-tions restored with SDR plus bulk fill and Tetric N flow bulk fill as initial increment with Tetric N ceram bulk fill composite resin in snow plow technique.

2 | METHODOLOGY

50 extracted mandibular molars free of caries, cracks, decay and restorations were selected for this study. All the selected teeth were stored in 0.5% chloramine T solution for 12 hours, and then washed and transferred to 0.9% saline solution. Standardized class II mesio occlusal box preparations were made with following dimensions - 3mm buccolingually and 2mm mesiodistally. Gingival seat of the proximal box was placed 1 mm above cementoenamel junction. The samples were randomly assigned into two groups of 25 teeth in each group for restorations. Samples of each group were mounted in contact with each other, Tofflemire matrix band and retainer was adapted to establish contact and restored as follows:

GROUP 1 – Flowable bulk fill (Tetric N Flow) and packable bulk fill composite resin (Tetric N Ceram) in snow plow technique. Restoration completed with packable bulk fill composite resin.

GROUP 2 – Flowable bulk fill (SDR plus) and packable bulk fill composite resin (Tetric N Ceram) in snow plow technique. Restorations were completed with packable bulk fill composite resin.

All restorations were finished and polished with soflex discs and points.

The samples were then stored in distilled water for 24 hours at 37 °C and then thermo-cycled for 500 cycles with dwelling time of 30 seconds and transfer time of 5 seconds, between 5°C and 55 °C. For microleakage assessment, the radicular apices of teeth were sealed with sticky wax and root and crown surfaces of the teeth were completely covered with nail varnish except for 1-2 mm around the margins of restorations. Specimens were then immersed in 2% methylene blue dye for 24 hours. After 24 hours, the samples were washed under tap water to remove the traces of the dye. The nail varnish was removed using polishing discs.

The teeth were placed in test-tubes containing 3 ml of 65 wt % nitric acid for 3 days. Test-tubes were centrifuged at 5,000 rpm for 5 mins. Supernatant from each sample was transferred to cuvettes. The dye absorbance was measured in a UV visible spectrophotometer at 550nm.

The results of the spectrophotometer indicate the dye absorbance of methylene blue in resin-dentin interface which indicates the microleakage of restoration. The results obtained were statistically analyzed and evaluated.

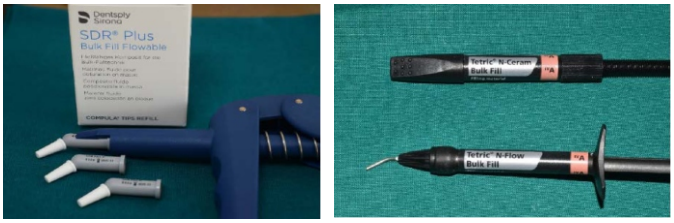

Fig 1 SDR plus and Tetric N Ceram bulk fill composite resins

Fig 2 Standardized class II mesio-occlusal box preparation

Fig 3 UV Spectrophotometer

3 | RESULTS

Data showed non-normal distribution, hence non-parametric test (Mann-Whitney U test) was applied. In this study, the microleakage score in teeth restored with group I & II were (IQR 0.0129) & (IQR 0.0116) respectively.

Mann-Whitney U test showed statistically significant difference between the groups (p=0.001). SDR plus bulk fill in snow plow technique showed lower microleakage compared to Tetric N flow bulk fill in snow plow technique.

Table 1: Comparison of the microleakage between the groups using Mann-Whitney U test

Groups	N	Min	Max	Median	IQR	p value
Tetric N flow Bulk fill	24	.0497	.0933	0.05890	0.0129	0.001*
SDR plus	24	.0331	.0601	0.0398	0.0116	0.001*

4 | DISCUSSION

Polymerization shrinkage of resin composites is a drawback leading to microleakage that influences success and longevity of restorations. Various techniques and materials have been tried to minimize microleakage.

One such method is the use snow plow technique introduced by Opdam in which a less viscous material is applied as gingival increment, overlayed by packable composite resin and co cured.7 This improves the marginal adaptation of the material and subsequently reduces the microleakage. Also, the flowable layer acts as a stress absorber, thereby reducing the overall polymerization shrinkage stresses.8

An invitro study by Peutzfeldt et al, reported significantly lower microleakage with snowplow technique using flowable and packable composite resins.13 The literature shows limited studies in this technique with bulk fill composite resin.

Bulk fill composite resins were used in this study, as they exhibit increased depth of cure and reduced polymerization shrinkage.

Tetric N-Ceram is characterized by its excellent esthetic properties and easy handling as well as its clinical longevity. Tetric N-Ceram Bulk Fill and Tetric N-Flow Bulk Fill both contain “ivocerin” as the photoinitiator which is highly photoreactive and provides for increased depth of cure of upto 4mm.11 The new “Aessencio” technology is responsible for lowering the translucency of the material during the polymerization process which allows it to blend in seamlessly with the surrounding dental tissues. It also contains a patented “shrinkage stress reliever” with a low modulus of elasticity(10GPa) that effectively reduces the stress during polymerization.12

SDR plus is another bulk fill composite resin that was developed with a patented larger molecular weight UDMA resin (molecular weight of 849 g/mol for SDR resin compared to 513 g/mol for Bis-GMA).17 The SDR technology comprises the unique combination of such a large molecular structure with a chemical moiety called a “Polymerization Modulator” chemically embedded in the resin matrix. The high molecular weight and the conformational flexibility around the centered modulator enables it to dissipate more energy (and store less) during polymerization.18 It is designed to be overlayed with a methacrylate-based universal/posterior composite for replacing missing occlusal/facial enamel.

A study was done by Kaisarly et al, to evaluate the effect of flowable liners beneath a composite restoration applied via different methods on the pattern of shrinkage vectors.8 The results showed that flowable liners act as a stress reliever, and recommended to apply a thin or thick layer of flowable liner beneath bulk-fill composites.

A study was done by Tabatabaei et al, to compare the gingival microleakage of Class II composite restorations through three restorative methods, Conventional incremental, open sandwich and snow plow.7 The results showed that there is less microleakage in snow plow technique in which the intermediate material is used, compared to conventional incremental method.

A study by Sampaio et al, evaluated composite placed with the snowplow technique versus incremental placement, using the low stress flowable bulk-fill composite (SDR flow) as the first uncured flowable layer.14 They assessed marginal adaptation with SEM and micro-CT and found that the snowplow method produced fewer gaps than an oblique incremental technique, but similar to a horizontal increment method with conventional composite.

In the present study, SDR plus with Tetric N ceram bulk fill composite resin in snow plow technique (group I) showed lower microleakage with a median of 0.05890 (IQR 0.0129) compared to Tetric N flow and Tetric N ceram bulk fill composite resin in snow plow technique (group II) with a median of 0.0398 (IQR 0.0116). The results were statistically significant ($P<0.05$). This can be attributed to the higher molecular weight of UDMA resin and the polymerization modulator in the resin matrix of SDR which impart flexibility and dissipate energy during polymerization. This results in a minimal overall shrinkage (3.5%) when compared to other flowable composites.16 And the "Self-levelling" ability provides excellent cavity adaptation and hence good marginal sealing property.17 This SDR layer overlaid with Tetric N ceram bulk fill composite and cured in snow plow technique, would have improved its adaptation and sealing ability, resulting in reduced microleakage values.

In this study, human permanent mandibular molars were selected as Class II lesions are most commonly encountered in molars. Microleakage is frequently detected on the proximal gingival margins.19 In this study, class II box cavities were prepared and all the cavities had similar dimensions of 3mm buccolingually and 2mm mesiodistally to standardize the preparation.21 The gingival margins of the cavities were placed 1mm above CEJ.

After completing the restorations, the specimens were subjected to thermocycling. Thermocycling is an invitro process of subjecting the specimens to extremes of temperature to simulate oral conditions. In the oral cavity, restorations are subjected to both thermal and mechanical stress that also contributes to the increase of marginal leakage. Thermocycling is widely used method to determine if temperature variation might influence the bond strength and to simulate in vitro thermal changes that occur in the oral cavity.

To assess sealing efficiency of restorative material & microleakage, the most common method is the use of various dyes. In this study, 2% methylene blue dye was chosen for dye extraction because it is simple, economical and does not require any complex laboratory apparatus. Even particle size of this dye is less than internal diameter of dentinal tubules (1-4 μm) and can show dentin permeability.18 In dye extraction method, teeth are dissolved in acids that release all dye from the interface and optical density of solution is measured by adsorbing light via spectrophotometer. Dye extraction method presents a benefit over fluid filtration technique, as filtration values tend to diminish over time, as the water penetrates all irregularities until a plateau is reached.20 Hence, dye extraction method was used in our study to evaluate microleakage.

5.2 | CONCLUSION

Within the limitations of the present study, it can be concluded that,

• Both bulk fill composite resin class II restorations in the study exhibited microleakage at the tooth restoration interface.

• Snow plow technique of restoring class II cavities with SDR plus and Tetric N ceram bulk fill composite resin showed lower microleakage compared to Tetric N flow and Tetric N ceram bulk fill composite resin in snow plow technique.

Further studies in much deeper class II cavities with gingival margins 1mm below CEJ and different cavity configurations, along with long term clinical trials are needed.

CONFLICT OF INTEREST

The Authors declare no conflict of interest.

REFERENCES

1. Ferracane JL, Lawson NC. Probing the hierarchy of evidence to identify the best strategy for placing class II dental composite restorations using current materials. J Esthet Restor Dent. 2021;33(1):39-50.
2. El-Mowafy O, El-Badrawy W, Eltanty A, et al. Gingival micro leakage of Class II resin composite restorations with fiber inserts. Oper Dent. 2007;32(3):298–305.
3. Radhika M, Sajjan GS, Kumaraswamy BN, et al. Effect of different placement techniques on marginal microleakage of deep class-II cavities restored with two composite resin formulations. J Conserv Dent. 2010;13(1):9–15.
4. Lindberg A, van Dijken JW, Lindberg M. Nine-year evaluation of a polyacid modified resin composite/resin composite open sandwich technique in Class II cavities. J Dent. 2007 1;35(2):124-9.
5. Patel P, Shah M, Agrawal N, et al. Comparative evaluation of microleakage of Class II Cavities Restored with different bulk fill composite restorative systems: An in vitro Study. J Res Adv Dent. 2016;5(2):52-62.
6. Bavaria S, Shah N, Shah R, et al. A comparative evaluation of micro leakage of two different bulk fill composites with ever x posterior composite for class II restorations by dye extraction method-an in vitro study. IOSR – JDMS.2017;16(1):72-77.
7. Tabatabaei SH, Tamandi M, Naebi M. Evaluating Microleakage of class II Composite Resin Restorations through various restorative approaches-An Invitro study. J Appl Med Sci.2017; 5(6D):2330-2336.
8. Kaisarly D, Meierhofer D, El Gezawi M, et al. Effects of flowable liners on the shrinkage vectors of bulk-fill composites. Clin Oral Investig. 2021;25(8):4927-40.
9. Jin X, Bertrand S, Hammesfahr PD. New radically polymerizable resins with remarkably low curing stress. J Dent Res. 2009;88:1651
10. Ilie N, Hickel R. Investigations on a methacrylate-based flowable composite based on the SDR™ technology. Dent Mater. 2011;27:348–55.
11. Patel P, Shah M, Agrawal N, et al. Comparative evaluation of microleakage of Class II Cavities Restored with different bulk fill composite restorative systems: An in vitro Study. J Res Adv Dent. 2016;5(2):52-62
12. Moosavi H, Moghaddas MJ, Kordnoshahri F, et al. Microleakage Evaluation of Bulk-fill Composites Used with Different Adhesive Systems. J Dent Biomater. 2018 13;5(2):544-50.
13. Peutzfeldt A, Asmussen E. Composite restorations: influence of flowable and self-curing resin composite linings on microleakage in vitro. Oper Dent. 2002;27(6):569-75.
14. Sampaio CS, Garcés GA, Kolakarnprasert N, et. External marginal gap evaluation of different resin-filling techniques for class II restorations-a micro-CT and SEM analysis. Oper Dent. 2020;45(4):E167-e75.
15. Swift EJ, Triolo PT, Barkmeier WW, et al. Effect of low-viscosity resins on the performance of dental adhesives. Am J Dent. 1996;9:100–4.
16. Giovannetti A, Goracci C, Vichi A, et al. Post retentive ability of a new resin composite with low stress behaviour. J Dent. 2012;40:322–8.

17.Burgess J, Cakir D. Comparative properties of low-shrinkage composite resins. Compend Contin Educ Dent. 2010;31:10–5.

18. Rossouw RJ, Grobler SR, Theunis J, et al. A comparison of microleak ages of five different recent bonding agents/systems in enamel and dentine. SADJ. 2007;62(5):213–8.

19. García L, Climent A, Llena C. In vitro evaluation of microleakage in Class II composite restorations: High-viscosity bulk-fill vs conventional composites. Dent Mater J. 2019;38(5):721–7.

20. Derkson GD, Pashley DH, Derkson ME. Microleakage measurement of selected restorative materials: a new in vitro method. J Prosthet Dent. 1986;56(4):435-40.

21. Majety KK, Pujar M. In vitro evaluation of microleakage of class II packable composite resin restorations using flowable composite and resin modified glass ionomers as intermediate layers. J Conserv Dent. 2011;14(4):414-417.

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