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Microleakage of Flowable Composite as Class I Restorative Materials

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Abstract

Aims: Evaluate the ability of different a bulk-fill flowable composite sealing around class I cavities compared to conventional composite. **Materials and Method**: Forty upper premolar teeth prepared with an ideal class I, then distributed according to types of composite resin into four groups (n=10): group I= filling with SDR, group II= filling with Sarmco flowable composite resin, group III= filling with Tg flowable composite resin, finally group IV= filling with Valux plus composite resin (as a control) polymerized by LED light cure unit, varnished and placed in 2% methylene blue then sectioned bucco-palatally. The Micro-leakage was determined by stereomicroscope. **Results**: There was a significant difference ($p<0.05$) in mean micro-leakage values between SDR (group I) and Saremco (group II) while there was no significant difference ($p>0.05$) in micro-leakage values between SDR (group I) and Tg (group III) and Valux plus (group IV). **Conclusion**: SDR can be applied in 4 mm as a lone layer without negative effect on micro-leakage.

الخلاصة

الأهداف: تهدف الدراسة الى تقييم قدرة السداد المركب القابل للتدفق الملء بكميات كبيرة حول تجاويف الفئة الأولى مقارنةً بالمركب التقليدي. **المواد وطرائق العمل**: أربعون ضاحكًا علويًا محضرًا من الدرجة الأولى المثالية ، ثم وزعت وفقًا لأنواع الراتينج المركب إلى أربع مجموعات (عدد العينات = ١٠): المجموعة الأولى = الحشو بـ الاستبدال الذكي لعاج الاسنانSDR ' المجموعة الثانية = الحشو براتنجsarmco ' المجموعة الثالثة =الحشو براتنج ' TG المجموعة الرابعة= الحشو براتنج valux ، بالإضافة إلى الراتينج المركب (كعنصر تحكم) المبلمر بواسطة وحدة المعالجة بضوء LED ، تم تلميع العينات ، ووضعها في ٢٪ ميثيلين أزرق ثم مقطوعة الشدق الحنكي. تم تحديد التسرب الدقيق بواسطة المجهر الفراغي. **النتائج**: كان هناك فرق معنوي ($p <0.05$) في متوسط قيم التسرب الدقيق بين SDR (المجموعة الأولى) و Saremco (المجموعة الثانية) بينما لم يكن هناك فرق معنوي ($p> 0.05$) في قيم التسرب الجزئي بين SDR المجموعة I و Tg المجموعة الثالثة و Valux plus المجموعة الرابعة .**الاستنتاجات**: يمكن تطبيق SDR في ٤ مليمتر كطبقة وحيدة دون تأثير سلبي على التسرب الجزئي.

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INTRODUCTION

Since the first introduction of composite resin material by Bowen, producers improved the mechanical and physical properties of resin base material [(1)]. However, the polymerization contraction continues to represent the major drawback in using direct composite resin restoratives. The shrinkage of composite resin could induce stresses at interface tooth-restoration if the stress exceeds the bond strength would be formed marginal gaps thus opening a path for leakage of microorganisms resulting in marginal micro-leakage [(2)]. Several materials have become advocated to reduce this gap [(1)]. Adhesive system produced a hybrid layer between composite and dentin wall to better seal margin because of bonding technology and the use of acidic. Additional produce marginal gap is the use of an intermediate elastic layer between the composite and bond that may compensate for the polymerization shrinkage stresses [(3)].

The Flowable composite was introduced has a filler size the same as hybrid composite but filler content lesser "60%_70% by weight and 60%_75% by volume". The reduced filler packing enhances flow and reduced modulus of elasticity. The low modulus of elasticity enables the flowable composites to bend with the tooth structure could act as a stressbreaker [(4)]. Seeing recent advances in the content of fillers or organic matrix, a new generation of flowable composite has been presented as bulk-fill flowable composite. It is little polymerization shrinkage accordingly lessen micro-leakage arising from this polymerization shrinkage [(5)].

SDR had been developed especially for dentine replacement and curing increments up to 4mm depth the polymerization shrinkage had been reduced by 50% or more compared to conventional composite resins. [(6)]

SDR is "a one-component, fluoride containing visible light cured, radiopaque resin composite restorative material". It is designed to be used beneath posterior composite restorations. SDR is flowable material that can be placed 4mm in thickness and light cured for 20seconds, and leave at least 2mm on the occlusal surface for ordered viscosity of composite. SDR materials are designed to be covered with a layer of standard composite for replacing missing enamel structure [(7)]. Bulk fill flowable composite makes the restorative procedure simpler, as it reduces the application time by reducing the clinical steps and does not need to pack them, therefore they have been desired by the clinicians [(8)].

The present study compared micro-leakage in class I was restored with flowable composites compared to a traditional hybrid composite resin (used as a control).

MATERIALS AND METHODS

The materials selected in this study, types, manufacturers' information and application are listed in (Table1).

Table 1: The materials, types, manufacturers' information and application

Materials	Manufacturer	Types	Application
SDR	Dentsply/USA	Flowable composite	4mm in one increment was left for a few seconds before it was cured by light (40 seconds).
Sarmco	Dental AG/Switzerland	Flowable composite	placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer
Tg	Technical and General Ltd, London, UK.	Flowable composite	placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer
Valux Plus	3M/USA	hybrid composite	placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer
Xeno V	Dentsply/USA	Bonding agent	a one step self-etching adhesive, was applied using the same method. excess solvent was removed using an air spra sec and polymerization was again performed LED light source for 10 sec

Specimens' preparation:

Forty caries - free human upper premolar teeth recently extracted for orthodontic purposes were selected for this study. After being stored in distal water at room temperature (23±2°C), teeth were cleaned with pumice stone and water. Class I cavities were prepared in each tooth (2 mm wide, 3 mm length, and 4 mm deep) using diamond burs in a high-speed, water-cooled. Prepared teeth were distributed into four groups randomly, with "n=10" teeth per group. Three groups were using different flowable composite resins, group I= filling with SDR showing in figure1 , group II= filling with Sarmco flowable composite resin, group III= filling with Tg flowable composite resin, while the final group filling with Valux plus conventional composite resin as a control, the teeth were filled using one bonding agent XenoV (Figure1) and cured by LED curing unit according to manufacture , then finished and polished with (TDV, Brazil) in a low- speed handpiece [(9)].

Figure 1: smart dentine replacement

Microleakage evaluation:

The teeth were stored in distal water for 7days at room temperature. After this time" thermocycled for (500 cycles) with baths held between (5˚C and 55˚C) and a dwell time (30 sec)" the apices of root were sealed by a cold -cure acrylic and three layers of nail varnish were useful on the tooth surfaces within (1mm) away from restoration margin [(10)].

All specimens were placed in"2% methylene blue solution for 24 hours" then rinsed under running water [(11)]. Specimens were inserted in a phenolic ring with epoxy resin and were segmented longitudinally in a buccopalatal direction showing (Figure2) with minitome (Figure 3b) then the lengths in millimeters of the dye penetration were examined with a stereomicroscope (motic images plus 2 program) [(12)](Figure 3a).

A non-parametric one-way ANOVA test was conducted ($P < 0.05$) and the least significant difference (LSD) was performed to test for any significant between all the groups using the SPSS software to statistically analyze the micro-leakage length.

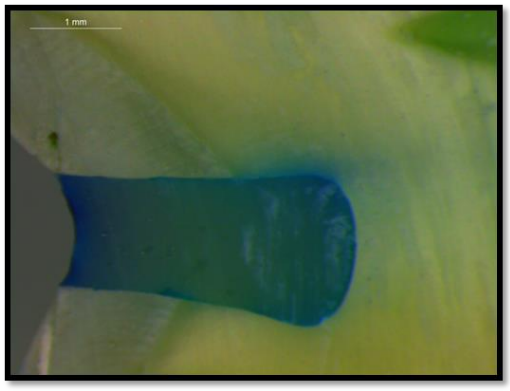

Figure 2: Specimen sectioned longitudinally in a buccopalatal direction

Figure3a: Stereomicroscope

Figure3b: Minitom machine

RESULTS

The mean and SD of micro-leakage are showed in (Table2) and (Figure4) a significant difference ($p<0.05$) between SDR (group I) and saremco (group II) and no significant difference ($p>0.05$) between SDR (group I) and Tg (group III) and valux plus (group IV) in values of micro-leakage by using ANOVA test (Table3). When the mean values of microleakage of the groups compared by LSD test (Table 4).

Table 2: Descriptive Analysis: Mean and SD of micro-leakage(mm) for all groups.

MATERIALS	N	Mean	Std. Deviation	Minimum	Maximum
TG	10	.5910	.38130	.17	1.45
SDR	10	.3950	.20898	.17	.73
VALUX	10	.5870	.27681	.19	.99
SAREMCO	10	.7060	.41719	.26	1.31
Total	40	.5698	.33802	.17	1.45

Table 3: One Way- ANOVA Test for all groups.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.499	3	.166	1.512	.228
Within Groups	3.958	36	.110		
Total	4.456	39			

Table 4: comparison among groups (micro-leakage (mm))

	MATERAILS	MATERAILS	Sig.	Level of significant
LSD	TG	SDR	.195	NS
		VALUX	.979	NS
		SAREMCO	.443	NS
	SDR	TG	.195	NS
		VALUX	.204	NS
		SAREMCO	.043	S
	VALUX	TG	.979	NS
		SDR	.204	NS
		SAREMCO	.428	NS
	SAREMCO	TG	.443	NS
		SDR	.043	S
		VALUX	.428	NS

DISCUSSION

Demand for posterior composite restorations has increased drama-tically, still stressand the polymer-ization shrinkage a major drawback of dental composite materials [13].

The polymerization shrinkage of a composite can cause contraction forces that may decrease the bond to the cavity walls leading to marginal failure and subsequent micro-leakage[14,15,16]. The micro-leakage causes post-operative sensitivity, marginal discoloration and secondary caries[17].

In this study, according to (Figure 4), there was lower micro-leakage in a group restored with SDR composite than other composites tested in the study, when groups SDR and Saremco were compared the results were statistically significant (P<0.05), SDR composite had significantly lower micro-leakage than Saremco composite. The probable reason for this is that the SDR is based on 'Stress Decreasing Resin technology' the SDR has less polymerization stress this will minimize negativities like micro-leakage arising from polymerization stress. According to the manufacturer, SDR contains a substance described as a "Polymerization Modulator was chemically embedded in the polymerizable resin backbone of the SDR resin monomer forms a relaxed network and provides lower polymerization stress than any other conventional resin, Through the use of the Polymerization Modulator"[18].

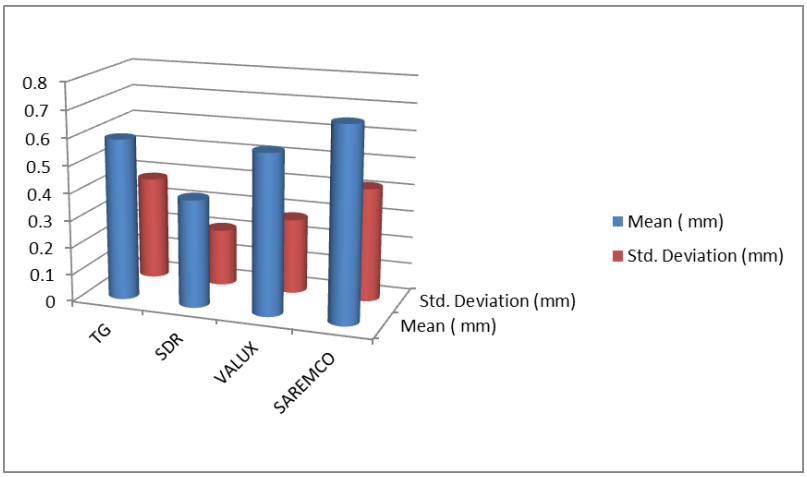

Figure 4: Micro-leakage for all groups on extracted human teeth using standardized class I occlusal preparation

In addition, the SDR contains an SDR patented urethane di-methacrylate resin that is responsible for the reduction in polymerization shrinkage and stress. This SDR technology, as it is referred to by the manufacturer, is a combination of a large molecular structured resin, SDR resin with a molecular weight (849 g/mol) substance called a "polymerization modulator" chemically integrated into the center of the SDR resin monomer [19].

The lowered shrinkage stress claimed by the manufacturer has been confirmed by Ilie *et al*., who found "the SDR showed the lowest contraction stress (1.1±.01MPa) not only when compared to the flowable materials but also when compared to nano- and micro-hybrid composites or even with the low shrinkage silorane-based material". They found that SDR showing the highest gel point and lowest shrinkage-rate consequently shrinkage stress would be reduced [20].

According to, Burgess *et* al., ([21] the SDR is planned to reduce shrinkage stress by increasing flow with an exclusive chemistry that slows the polymerization rate, thereby reducing shrinkage stress.

Koltisko *et* al., ([22] concluded that the polymerization shrinkage stress was lower for SDR than other resin composites tested.

Another important detail to be considered is that the SDR has a self-leveling characteristic and excellent adhesion to the preparation walls because of its flowable nature, fill all the crevices and reducing the potential for voids formation. [7]

The results of the present-day study agreed with Scotti, *et al*.,[23] who revealed that at dentinal margins, the Surefil SDR has less micro-leakage due to its lower stress owing to the low elastic modulus, and its lower wettability.

Koyuturk *et al*., [24] reported successful results about the SDR micro-leakage in their study which they compared posterior composite and SDR with self and total etch adhesive systems.

In the study of Alkhudhairy FI and Ahmad ZH.[25], SDR showed better micro-leakage quality as urethane with incorporated photoactive groups can control the polymerization kinetics.

Elhawary *et al*. [26] shown that SDR flowable composite recorded the value of micro-leakage lowest scores among the four groups in both occlusal and cervical margin.

In the study of Jawaed *et al*., [27] the SDR one - step technique demonstrated significantly less leakage value than the traditional incremental technique. Observations under stereomicroscope showed a better marginal adaptation in SDR technique specimens.

The results of the study by Kapoor *et al*., [28] showed the SDR composite resin demonstrated the best adaptability and less gap formation than incrementally filled composites.

The authors recognize that the generally results of this current study can be used to clinical performance. However, the authors advocate invasive Class I composite restorations be restored using flowable composites have been validated in long-term controlled clinical trials.

CONCLUSION

Microleakage varied substantially, among the material groups tested. Bulk - fill SDR composite resin can be applied 4 mm in a single layer without a negative

effect on micro-leakage. Moreover SDR can reduce micro-leakage used with its manufacturer's recommended bonding agent, leaked significantly less than a wide variety of flowable composites used with same bonding agents.

Conflict of interest: none

Ethical statements: the avoidance of the risk of plagiarism and respect for intellectual property; Respect for the rights of human subjects in research; The identification of and dealing with allegations of research misconduct; The identification of and dealing with manipulations of citations; The disclosure of any conflicts of interest.

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REFERENCES

1. Moorthy A. HoggC.H. DowlingA.H. Grufferty B.F. Benetti A.R. and Fleming G.J.P. Cuspal deflection and micro-leakage in premolar teeth restored with bulk_fill flowable resin_based composite base materials.*J of Dentistry* 2012; 12:2-26.
2. Burke FJ, Shotall AC. Successful restoration of load -bearing cavities in posterior teeth with direct replacement resin-based composite. *Dent Update* 2001; 28(8):388-394.
3. Montes MA, de Goes MF, Da Cunha MR &Soares AB. Amorphological and tensile bond strength evaluation of unfilled adhesive with lowviscosity composites and filled adhesive in one and two coats. *J of Dentistry*2001; 29(6): 435-441.
4. Kleverlaan CJ and Feilzer AJ .Polymerization shrinkage and contraction stress of dental resin composites. *Dental Material* 2005; 21(12):1150-1157.
5. Czasch P, Ilie N. In vitro comparison of mechanical properties and degree of cure of bulk fill composites. *Clin Oral Investig*ation 2013; 17(1):227-235.
6. Atalay C, Yazici AR, Horuztepe A, Nagas E, Ertan A, Ozgunatltay G. Fracture resistance of endodontically treated teeth reatored with bulk fill, bulk fill flowable, fiber-reinforced and conventional resin composite. *Operative dentistry* 2016;41: E131-40.
7. Inside Dentistry. Surefil SDR flow Posterior Bulk Fill Flowable Base. 2009; October, p124.
8. Moorthy A, Hogg CH, Dowling AH, Grufferty BF, Benetti AR *et al*. Cuspal deflection and micro-leakage in premolar teeth restored with bulk-fill flowable resin-based composite base materials. *J Dent*istry. 2012; 40(6):500-505.
9. KanikaVerma Gupta KVG, PradhumanVerma PV and AshwaryaTrivedi AT. Evaluation of Micro-leakage of Various Restorative

Materials:AninVitro Study. *J Life Science* 2011; 3(1): 29-33.

10. Ali Abdulwahab AL-razooki AA and Mohammad Mustahsen UR Rehman MR. Micro-leakage in ClassvNanofilled Composite Compared with Traditional Hybrid and Flowable Composite Restorations; An invitro study. *Pakistan Oral & Dental J*.2010; (30) 1:215-219.
11. Xie H, Zhang F, Wu Y, Chen C and Liu W. Dentine bond strength and micro-leakage of flowable composite, compomer and glass ionomer cement. *Australian Dental J*. 2008; 53: 325–331.
12. Bahlakeh M,Omidi S, Lomee M, Cherati JY. Microleakage Assessment of A New Mineral Trioxide Aggregate Based Root Canal Sealer In the Presence and Absence of Saliva. *Annals of Dental Specialty* 2018;6(3):321-326
13. -Ferracane J, Kwon Y and Lee, IB. Effect of layering methods composite type and flowable liner on the polymerization shrinkage stress of light cured composites. *Dental materials* 2012; 28 :801–809.
14. Bagis YH, Baltacioglu IH, Kahyaogullari S. Comparing micro-leakage and the layering methods of silorane – based resin composite in wide classII MOD cavities. *Operative Dentistry* 2009; 34:578–85.
15. Kidd EAM. Micro-leakage: a review. *J Dent*istry 1976; 4:199-205.
16. Davidson CL, De Gee AJ, Feilzer A. The competition between the composite dentin bond strength and the polymerisation contraction stress. *Dental Reseach J* 1984; 63(12) :1396-1399.
17. Cellik O, Yavuz Y, Bahsi E, Yilmaz H Y. The Comparison of the Micro-leakage of Two Different Bulk-Fill Materials in Teeth Disinfected By Ozone Gas. *Advance Dental & Oral Health*. 2016; 1(4): 1-5.
18. Surefil SDR. Flow Product Brochure. *Dentsply International* 2010. Available from:http://www.surefilsdrflow.com/sites/default/files/SureFil_Brochure.Pdfhttp://www.surefilsdrflow.com/sites/default/files/SureFilSDRflow_brochure.pdf .
19. Scientific Compendium SDR™ (2011) dentsply. pdf. Available from: http://dentsplymea.com/sites/default/files/Scientific%20compendium20SDR%20-%202011.pdfOr:http://www.dentsply.eu/bausteine.net/file/showfile.aspx?downdaid=8854&sp=E&domid=1042&fd=2 .
20. Ilie N, Hickel R. Investigations on a methacrylatebased flowable composite based on the SDR™technology. *Dental materials* 2011; 27:348–355.

21. Burgess J; and Cakir D. Comparative Properties of Low Shrinkage Composite Resins .*Compend Contin Eductution Dent*istry 2010; 31(2):10-15.
22. Koltisko B, Dai Q, Jin X, Bertrand S. The polymerization stress of flowable composites. *J Dental Reseach* 2010; 89:321.
23. Scotti N, Comba A, Gambino A, Paolino DS, Alovisi M, Pasqualini D, and Berutti E. Micro-leakage at enamel and dentin margins with a bulk fills flowable resin. *Europe J Dental* 2014;8(1):1-8.
24. Koyuturk AE, Sari ME, Ozmen B, Tokay U, Cortcu M, et al. Influence of the Bulk Fill Restorative Technique on Micro-leakage and Micrtensile of classII restorations. *Pediatric Dental Journal* 2014; 24(3): 148- 152.
25. Alkhudhairy FI and Ahmad ZH. Comparison of Shear Bond Strength and Micro-leakage of Various Bulkfill Bioactive Dentin substitutes: An invitro study. *J Contemp Dent Pract* 2016;17(12):997-1002.
26. Elhawary AA, Elkady AS, Kamar AA. Comparison of degree of conversion and micro-leakage in bulkfill flowable composite and conventional flowable composite: an invitro study. *Alexandria Dental J* 2016; 41:336-343.
27. Jawaed NUA, Ali Abidi SY, Qazi FUR and Ahmed S (2016). An invitroEvaluation of Micro-leakage at the Cervical Margin between two Different classIIRestorative Techniques using dye Penetration Method. *College of Physicians and Surgeons PakistanJ* 2016; 26 (9): 748-752.
28. Kapoor N, Bahuguna N andAnand S. Influence of Composite Insertion Technique on Gap Formation. *Conservative Dentistry J*. 2016 ;19(1):77-81.