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Research Article

Impact of Stress Decreasing Flowable Resin Composite on Marginal Quality

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Abstract

Objective: To evaluate marginal integrity of Class II nano hybrid composite restorations line with SDR flowable composite using optic coherence tomography (OCT).

Materials and Methods: Thirty mesio-occluso-distal cavities were prepared in extracted human molars. The cavities (n = 10) were restored and were equally divided into three groups. Group I nanohybrid composite, group II nanohybrid composite/SDR flowable composite and group III nanohybrid composite/nanoflowable composite. Marginal gaps were analyzed using OCT, before and after thermocycling, then specimens were cut longitudinally in order to investigate internal dentin adaptation by OCT.

Results: There were no significant differences ($p > 0.05$) for marginal and internal adaptation test between the tested groups.

Conclusions: SDR flowable composite showed good performance as a liner under nano hybrid composite restorations.

Keywords: *Bulk Fill; Flowable Liner; Marginal Adaptation; Optic Coherence Tomography; Polymerization Shrinkage*

Introduction

Un-fortunately due to the polymerization shrinkage, all resin-based composites have a degree of volume contraction that will lead to loss of marginal integrity and result in marginal leakage [1]. As a consequences [2], restoration failure will occur [3,4].

For clinical success, a gap-free margin is mandatory for the clinician. Although, a gap-free margin is not completely obtained [5-7]. Analysis of the can be produced using various methods. Optic coherence tomography (OCT) is a possible technique for analysis of marginal quality of restorations [8,9].

Flowable resin composites are low viscosity resin, with 20 - 25% lower filler loading than conventional resin composites, appeared in the 1990s [10,11]. Recently, available clinical reports concluded that application of flowable resin composites in occluding surfaces under stress is not recommended [12].

Smart Dentin Replacement (SDR) is a visible light cured resin composite, fluoride-containing and handled like flowable resin composites [13]. Although flowable resin composites introduced to act as shock absorbable and improve adaptation [14], clinical evaluations could not prove this idea so far [11-13]. Therefore, the aim of this study was to evaluate marginal and internal adaptation of SDR as a liner under class II nano hybrid resin composite restorations using OCT. The null hypotheses tested here were: 1) no statistically significant difference in the polymerization shrinkage values between the two flowable resins composite evaluated; 2) no statistically significant difference in marginal and internal adaptation of nano-hybrid restorations lined with or without SDR.

Materials and Methods

Two resin-based flowable composite materials; SureFil SDR and Tetric N Flow, were used as a lining. Tetric N Ceram nano-hybrid resin composite with Excite adhesive system were used as a capping restoration (Table 1).

Thirty extracted sound human molars were selected and stored in 0.5% chloramines T aqueous solution at 4oC. Thirty standardized MOD cavity preparations with gingival steps of 2 mm at the mesial and distal margins of the box, which was located 1 mm above the cemento-enamel margin. Bucco-lingual width of cavity was 4 mm, while the depth of the cavity was 4 mm. Prepared cavities were divided into three groups; ten cavities per each group, as follow:

- Group I restored with Tetric N Ceram
- Group II restored with SureFil SDR Flow/Tetric N Ceram
- Group III restored with Tetric N Flow/Tetric N Ceram.

Brand Name	Specification	Manufacturer	Composition
Tetric N Ceram	Nano- hybrid resin composite	Ivoclar/Vivadent	**Matrix**: UDMA, Bis-GMA **Filler**: Barium glass, Ytterbium trifluoride, Mixed oxide prepolymer
SureFil SDR Flow	Bulk- Fill flowable resin composite	Dentsply Caulk, Milford, DE, USA	**Matrix**: Polymerization modulator, dimethacrylate resins, UDMA **Filler**: Ba-B-F-Al silicate glass, SiO_2, amorphous, Sr-Al silicate glass, TiO_2
Tetric N Flow	Nano-filled flowble resin composite	Ivoclar/Vivadent	**Matrix**: UDMA, Bis-GMA **Filler**: Barium glass, Ytterbium trifluoride, Mixed oxide prepolymer
Excite	Two- step- etch and rinse	Ivoclar/Vivadent	**Etchant:** 73% phosphoric acid with colloidal silica **Adhesive**: HEMA, DMA, phosphoric acid acrylate, silicon dioxide, initiator, stabilizers in an alcohol solution.

Table 1: *Restorative materials used.*

A metal matrix band was applied, and each tooth was bonded with Excite adhesive system and polymerized for 20s in all cases. For group I, all cavities were restored in oblique incremental technique of 2 mm thickness and light-cured for each increment. For group II, the cavities were first restored with SDR Flow with 4 mm bulk and the occlusal 2 mm was restored with Tetric N Ceram resin composite. For group III, all cavities were first lined with Tetric N flow resin composite and polymerized for 20s. The remaining of the cavity was restored in oblique layering technique of 2 mm thickness with Tetric N Ceram resin composite and light-cured. Both buccal and lingual aspects of restorations were light cured with additional 20s and proximal margins were finished with flexible disks.

The marginal adaptation was evaluated using OCT (3D OCT 2000, Topcon Corp, Tokyo, Japan), immediately after photo-polymerization. After one weak and one month of storage in normal saline, the teeth were re-evaluated using OCT, after thermo-cycling.

The thermal loading was done by thermal cycling of specimens in a thermal cycling machine for 500 cycles between (50c) (±10c) and (550c) (±10c). The dwell time in each temperature was 30 seconds and the transferring time between its containers was 20 seconds.

Marginal qualities were classified “gap-free margin”, “gap/irregularity” and “not judgeable/artifact”. Marginal integrity quality was calculated as the percentage of “gap-free margin” in relation to the individual judgeable margin [14].

For internal adaptation evaluation, the teeth were sectioned mesio-distally using a slow-speed diamond saw* and both sections were phosphoric acid etched for 2 minutes, rinsed and dried. Evaluations were made using OCT in the same manner like marginal adaptation evaluation. Two way analysis of variance (ANOVA) and Tukey multiple range test using the SAS system were used.

Results

Immediately after polymerization, no change in the marginal adaptation of the tested restorative materials was detected. Immediately after polymerization, all the tested groups exhibited the highest frequency (100%) of GF restorations. These results were unchanged after 1 weak of thermo cycling. After 1 month, the frequency of GF restorations became 80% for group I and 90% for group II and 75% for group III, but with no statistically significant differences were detected (Figure 1).

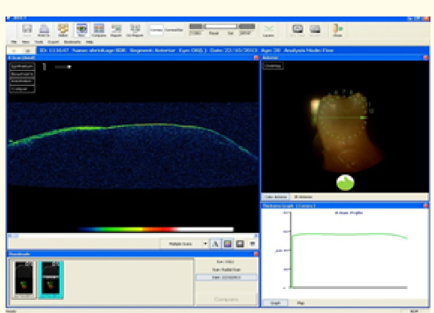

Figure 1: *A photograph showing gap-free margin of lower first molar restored with Esthet-x HD/SureFil SDR after one month of thermo cycling produced by OCT.*

Two-way ANOVA analysis results in a statistically significant difference ($p < .0001$) among the tested restorative materials with no significant effect of thermo cycling time to all restorative systems. At different thermo cycling times, group I exhibited significantly higher values compared with group II and group III composites ($p < .0001$).

	MG (µm)			DM (%)			MI		
Resin Composite	**Immediate**	**1 weak**	**1 month**	**Immediate**	**1 weak**	**1 month**	**Immediate**	**1 weak**	**1 month**
Group I	5.1 ± 0.6^{a}	5.1 ± 0.6^{a}	5.2 ± 0.5^{a}	6.3 ± 0.1^{a}	6.4 ± 0.09^{a}	6.5 ± 0.09^{a}	0.32 ± 0.03^{a}	0.33 ± 0.03^{a}	0.34 ± 0.03^{a}
Group II	7.90 ± 1^{b}	7.90 ± 0.9^{b}	8.50 ± 1^{b}	11.2 ± 0.2^{b}	11.3 ± 0.05^{b}	11. 9 ± 0.1^{b}	0.88 ± 0.1^{b}	0.89 ± 0.1^{b}	1.01± 0.1^{b}
Group III	16.8 ± 2.9^{c}	16.9 ± 2.9^{c}	18.5 ±2.8^{c}	18.7 ± 0.2^{c}	18.9 ± 0.2^{c}	19.9 ± 0.1^{c}	3.14 ± 0.4^{c}	3.19 ± 0.5^{c}	3.68 ± 0.4^{c}

Table 2: *Means and SD of resin composite systems used.*
Means in the same column with the same superscripted letters are not significantly different ($p < 0.05$).

Immediately after polymerization, no change in the internal adaptation of the tested restorative systems was detected. Immediately after polymerization, all the tested groups exhibited the highest frequency (100%) of GF restorations. These percentages unchanged after 1 weak and 1 month of thermo cycling for group II and III, while the frequency of GF restorations for group I after 1 weak of thermo cycling became 90% and 80% after 1 month with no statistically significant differences were detected (Figure 2).

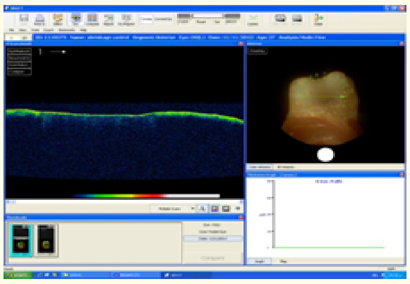

Figure 2: *A photograph showing gap-free margin of sectioned lower first molar restored with Esthet-x HD/SureFil SDR Flow after one month of thermo cycling produced by OCT*

Two-way ANOVA analysis results in a statistically significant difference ($p < .0001$) with no significant effect of thermo cycling time of all restorative systems. At different thermo cycling times, group I exhibited significantly higher values compared with group II and group III resin composites ($p < .0001$) and no significant difference among group II and group III.

	MG (µm)			DM (%)			MI		
Resin Composite	**Immediate**	**1 weak**	**1 month**	**Immediate**	**1 weak**	**1 month**	**Immediate**	**1 weak**	**1 month**
Group I	16.9 ± 0.6^{a}	7.1 ± 0.6^{a}	16.9 ± 0.5^{a}	18.9 ± 0.1^{a}	18.9 ± 0.09^{a}	19.9 ± 0.09^{a}	3.14 ± 0.03^{a}	3.19 ± 0.03^{a}	3.68 ± **0.03**^{a}
Group II	7.1 ± 1.2^{b}	6.1 ± 0.9^{b}	8.50 ± 1.2^{b}	5.2 ± 0.1^{b}	5.3 ± 0.05^{b}	5. 9 ± 0.2^{b}	0.16 ± 0.1^{b}	0.16 ± 0.2^{b}	0.11 ± **0.2**^{b}
Group III	8.90 ± 2.9^{b}	5.90 ± 2.9^{b}	9.5 ± 2.8^{b}	6.3 ± 0.2^{b}	6.4 ± 0.2^{b}	6.5 ± 0.1^{b}	0.32 ± 0.4^{b}	0.33 ± 0.5^{b}	0.34 ± **0.4**^{b}

Table 3: *Means and SD of resin composite systems used.*
Means in the same column with the same superscripted letters are not significantly different ($p < 0.05$).

Discussion

The present study investigated a new flowable resin composite, applied as a liner. It was recently produced on the European market under the name SDRTM Posterior Bulk Fill Flowable Base. One nano-hybrid flowable methacrylate-based composite was considered as a gold standard for evaluation of the material.

SDR characterized with Stress Decreasing Resin (SDR) technology. This new technology is responsible for the reduction in polymerization shrinkage and stress. This is due in part to the larger size of the SDR resin compared to conventional resin and to polymerization modulator chemically embedded in the center of the polymerizable SDR resin monomer [15].

Specimen size is a limitation when making measurements using OCT. This was attributed to the area of scan was not exceed 6 mm. Depending on the optical properties of the sample; specimen thickness can be a major drawback. Previous pilot studies confirmed that at 0.5 mm, visible light can pass through the entire thickness of the sample and backscatter. Depending on the optical setup, the linear shrinkage results must be calculated in a second moment using computerized imaging processing and analysis by a caliber (Image J). However, the OCT method is still advantageous considering the technique's potential for performing *in vivo* measurements [16-19].

The results of the present study disagree with Cheetham JJ., *et al*. [20] whom reported that, no significant differences observed when comparing RMGIC to bulk-fill resin composite tested.

The purpose of using adhesives with resin composite restorations is to obtain a 100% perfect seal between the tooth structure and resin composite [21]. Above all, the bond has to be strong enough to withstand the resulting stresses of polymerization shrinkage process during curing.

For marginal adaptation evaluation, the high viscosity nano-hybrid resin composite restorations without liner produce the lowest frequency for gap-free restorations. For internal adaptation evaluation, nano-hybrid resin composite restorations lined with SDR flowable resin composite exhibited high frequency of gap-free restorations, even after one year of storage and thermo cycling. This can attributed to the SDR flowable resin composite has optimum adaptation to the prepared cavity walls, and minimal polymerization shrinkage stresses; as discussed before in polymerization shrinkage test, compared to nano-hybrid resin composite restorations lined with nano-flowable resin composite.

The results of the present study disagree with Pecie R., *et al*. [21] whom concluded that application of a flowable composite did not significantly produce high marginal adaptation. Also, the results of the present study disagree with Campos EA., *et al.* [22] that concluded that, by using simple layering techniques, bulk-fill materials do not improve marginal adaptation than conventional composite.

On the other hand, the results of the present study agree with Reddy SN., *et al*. [23] whom concluded that ultrathin flowable composite lining, improved the marginal sealing with decreased microleakage. Also, Nazari A., *et al*. [19] concluded that SDR flowable resin composite performed better than conventional composite.

Conclusion

In accordance with the limitations of this study, the following conclusions can be found:

1. SDR resin-based flowable composite showed an acceptable low polymerization shrinkage compared to the nano-flowable resin composites with high marginal and internal adaptation.
2. All the tested restorative systems failed to achieve polymerization shrinkage-free conditions.
3. OCT is a valuable tool for marginal quality and polymerization shrinkage measurements, but has limited penetration depth and scanning range.

Bibliography

1. Koplin C., *et al*. "Kinetic model for the coupled volumetric and thermal behavior of dental composites". *Dental Materials* 24.8 (2008): 1017-1024.

2. Petrovic IM and Atanackovic TM. "A model for shrinkage strain in photo polymerization of dental composites". *Dental Materials* 24.4 (2008): 556-560.

3. Kleverlaan CJ and Feilzer AJ. "Polymerization shrinkage and contraction stress of dental resin composites". *Dental Materials* 21.12 (2005): 1150-1157.

4. Peutzfeldt A and Asmussen E. "Determinants of in vitro gap formation of resin composites". *Journal of Dentistry* 32.2 (2004): 109-115.

5. Amore R., *et al*. "Polymerization shrinkage evaluation of three packable composite resin using a gas pycnometer". *Pesquisa Odontológica Brasileira* 17.3 (2003): 273-277.

6. Pereira RA., *et al*. "Comparative analysis of the shrinkage stress of composite resins". *Journal of Applied Oral Science* 16.1 (2008): 30-34.

7. Bayne SC., *et al*. "A characterization of first-generation flowable composites". *Journal of the American Dental Association* 129.5 (1998): 567-577.

8. Perdigao J., *et al*. "The effect of adhesive and flowable composite on postoperative sensitivity: 2-week results". *Quintessence International* 35.10 (2004): 777-784.

9. Freitas AZ., *et al*. "Imaging carious human dental tissue with optical coherence tomography". *Journal of Applied Physics* 99 (2006): 024906.

10. Reis A and Loguercio AD. "A 24-month follow-up of flowable resin composite as an intermediate layer in non-carious cervical lesions". *Operative Dentistry* 31.5 (2006): 523-529.

11. Celik C., *et al*. "Clinical evaluation of flowable resins in non-carious cervical lesions: two-year results". *Operative Dentistry* 32.4 (2007): 313-321.

12. Van Dijken JW and Pallesen U. "Clinical performance of a hybrid resin composite with and without an intermediate layer of flowable resin composite: a 7-year evaluation". *Dental Materials* 27.2 (2011): 150-156.

13. Pereira JC., *et al*. "Evaluation of internal adaptation of class V resin composite restorations using three techniques of polymerization". *Journal of Applied Oral Science* 15.1 (2007): 49-54.

14. Monteio CGM., *et al*. "Marginal analysis of resin composite restorative systems using optic coherence tomography". *Dental Materials* 27.12 (2011): e213-e223.

15. Soares CJ., *et al*. "Polymerization shrinkage stresses in a premolar restored with different composite resins and different incremental techniques". *Journal of Adhesive Dentistry* 15.4 (2013): 341-350.

16. De Melo Monteiro GQ., *et al*. "Alternative methods for determining shrinkage in restorative resin composites". *Dental Materials* 27.8 (2011): 176-185.

17. Klautau EB., *et al*. "Low shrinkage composite resins: influence on sealing ability in unfavorable C-factor cavities". *Brazilian Oral Research* 25.1 (2011): 5-12.

18. Zaruba M., *et al*. "Comparison between different flow application techniques: SDR vs flowable composite". *Journal of Adhesive Dentistry* 15.2 (2013): 115-121.

19. Nazari A., *et al*. "3D assessment of void and gap formation in flowable resin composites using optical coherence tomography". *Journal of Adhesive Dentistry* 15.3 (2013): 237-243.

20. Cheetham JJ., *et al*. "A comparison of resin-modified glass-ionomer and resin composite polymerisation shrinkage stress in a wet environment". *Journal of the Mechanical Behavior of Biomedical Materials* 29 (2014): 33-41.

21. Pecie R., *et al*. "Marginal adaptation of direct class II composite restorations with different cavity liners". *Operative Dentistry* 38.6 (2013): E210-E220.

22. Campos EA., *et al*. "Marginal adaptation of class II cavities restored with bulk-fill composites". *Journal of Dentistry* 42.5 (2014): 575-581.

23. Reddy SN., *et al*. "The effect of flowable composite lining thickness with various curing techniques on microleakage in class II composite restorations: an in vitro study". *Journal of Contemporary Dental Practice* 14.1 (2013): 56-60.

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