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Research Article

Evaluation of Polymerization Shrinkage of Smart Dentin Replacement Flowable Resin Composite Using Optic Coherence Tomography

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Received: December 10, 2018; **Published:** December 31, 2018

Abstract

Objectives: To evaluate polymerization shrinkage of SDR flowable composite using optic coherence tomography.

Material and Methods: Two flowable composites were applied to a cylindrical Teflon mold (5 mm × 2 mm), polymerized and removed from the mold (n = 10 for each material). Optical coherence tomography was used for linear shrinkage evaluations.

Results: There were high significant differences ($p > 0.05$) between the tested groups.

Conclusions: SDR resin-based flowable composite showed an acceptable low polymerization shrinkage compared to the nano-flowable resin composites.

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

Introduction

For clinical success, a gap-free margin has to be the primary goal for the clinician [1-4]. Although many developments in the field of adhesives, a gap-free margin is not completely obtained [5-7]. Optic coherence tomography (OCT) is a possible technique for analysis of tooth-restoration interface, introduced in medicine at the beginning of 1990s [8,9].

Flowable resin composites are low viscosity resin, with 20 - 25% lower filler loading than conventional resin composites, appeared in the 1990s [10,12]. Smart Dentin Replacement (SDR) is a visible light cured resin composite, fluoride-containing and handled like flowable resin composites. It can be placed in 4-mm increments and must covered by a 2-mm layer of conventional resin composite [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 objective of the present study was to evaluate polymerization shrinkage of SDR flowable RBC using OCT. The null hypotheses tested was no statistically significant difference in the polymerization shrinkage values between the two flowable resins composite evaluated.

Materials and Methods

In this study, two flowable lining materials, SureFil SDR and Filtek Z350XT Flow were used. The restorative materials were used according to manufacturers' recommendations and only one operator performed all the procedures of specimen's preparations.

Brand Name	Specification	Manufacturer	Composition
SureFilSDR 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
Filtek z350xt Flow	Nano-filled flowable resin composite	3M ESPE; St Paul, MN, USA	**Matrix**: BisGMA, TEGDMA, BisEMA 6, functionalized dimethacrylate **Filler**: Ceramic, SiO_2, ZrOx

Table 1: *Restorative materials used.*

A twenty cylindrical Teflon mold (5 mm diameter + 2 mm height) was used to assess linear polymerization shrinkage (n = 10 for each material) by OCT (3D OCT 2000, Topcon Corp, Tokyo, Japan). To execute the scans, insert and photoactivate the composite, the mold was fixed onto a sliding rail [13].

At the beginning of each specimen preparation, the empty mold was scanned to ensure its accurate height. Resin composites were inserted into the mold and then covered with a very thin microscope glass slab. Filtek z350 XT Flow resin composite for group I and SureFil SDR Flow resin composite for group II. A thicker microscope glass slab was placed over the whole assembly and manually pressed against the mold to ensure adequate resin accommodation inside the cavity and then it was removed. In a dark room, a second scan was performed to register the exact amount of uncured resin.

Photo activation was performed using the established protocol (20s), and the very thin microscope glass slab was then carefully removed from the upper side of the specimens. Fifteen minutes later, another scan was performed.

The optical distance was obtained from the OCT images and the real distance refers to the real thickness of the samples, which was measured from the height of the Teflon mold confirmed by a digital caliber. Images were analyzed using the Image J program (Image Processing and Analysis in Java) [13].

Linear shrinkage was then calculated using the formula:

$$\text{Linear shrinkage} = \frac{\text{RC0min - RC15min}}{\text{RC0 min}} \times 100\%$$

Where RC0 min is the mean resin thickness when it is still un-polymerized, and RC15 min is the polymerized mean resin thickness. Statistical analysis of the data was performed with t- test to compare between the two tested materials.

Results

T-test was performed to compare between the tested two groups. The results revealed high statistical significant difference between the tested two materials at $p < 0.05$.

Materials	N	Mean	Std. Deviation	Minimum	Maximum	P value	T value
Group I	10	1.0260	0.0574	0.9000	1.1000	0.0015**	3.730
Group II	10	0.8460	0.1412	0.6000	1.0000		

Table 2: *Mean and SD of polymerization shrinkage (%) values of the tested composite materials.*

**Significant p < 0.05.*

Discussion

The present study investigated a new flowable resin composite, applied as a liner in Class I and II restorations. The material was recently produced on the European market under the name SDRTMPosterior 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 a urethane dimethacrylate structure that allow reaction to other typical methacrylate systems currently used in nearly all composite restorative materials and 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].

Many methods can be used for polymerization shrinkage measurements. According to our results, we strongly agree with previous studies that reported that the amount of shrinkage of a resin composite depends on the method used to measure that shrinkage.

By using OCT, time-resolved measurements of the group refractive index, of a dental composite sample before, during and after the curing process can be obtained [13].

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 (ImageJ). However, the OCT method is still advantageous considering the technique's potential for performing *in vivo* measurements [16]. The results of the present study disagree with Cheetham JJ., *et al*. [17] whom reported that, no significant differences observed when comparing RMGIC to bulk-fill resin composite tested.

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.
2. All the tested restorative systems failed to achieve polymerization shrinkage-free conditions.
3. OCT is a valuable tool for polymerization shrinkage measurements, but has limited penetration depth and scanning range.

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Volume 18 Issue 1 January 2019