

Microleakage Differences on Composite Resin Restoration with and without Nanohybrid Flowable Composite Resin as a Surface Sealant

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Abstract

Polymerization shrinkage occurred in composite resin restoration during the polymerization process. Polymerization shrinkage may cause microleakage in the middle of restoration margin and resulting in bacteria, debris, ion, and molecule penetration in margin of composite resin restoration. Secondary caries, pulpal sensitivity, restoration crack, and pulpal irritation are some complications of polymerization shrinkage. Surface sealant application on composite restoration surface prevents microleakage. Surface sealant with nanohybrid filler is fine preference to prevents microleakage due to its physical properties and a good wear resistance.

The aim of this study is to analyze of nanohybrid flowable composite resins as a surface sealant on microleakage score in composite resin restoration.

Upper premolar teeth (n=16) with class I cavity were divided into two groups. Group 1 was treated with packable composite restoration without surface sealant application. Group 2 was treated with packable composite restoration with nanohybrid flowable composite as a surface sealant. All groups immersed in 0.5% of methylene blue solution for 24 hours and then rinsed with water and separated bucco-lingually with carbondurum disc. Afterward, each section assessed for dye penetration to represent microleakage by using a scoring method under a digital microscope. Data were collected and statistically analyzed using Man Whitney.

The restoration with nanohybrid flowable composite surface sealant application shows a significant difference between group 1 and group 2 (p<0,05).

Nanohybrid flowable composite surface sealant shows a significant result to decrease microleakage score in resin composite restoration.

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Introduction

Composite resin is one of the most widely used materials for filling. This material is selected due to its good mechanical performance, wear resistance, and aesthetic potential.¹ One of its disadvantages is polymerization shrinkage. During polymerization process, monomer reacts among themselves and form polymer chains. Molecules which interact to each other begin to react with formation of covalent bonding. This process leads to increase the density due to total

volume reduction.^{2,3,4} Polymerization shrinkage cause microleakage at the marginal sealing of restorations that allows the entry of bacteria, fluids, molecules and ions between the cavity walls and the restorative materials.^{1,5,6} This leads to tooth sensitivity, recurrent caries, marginal staining pulpal, and pulp irritation.^{2,6}

Several methods to overcome the microleakage problem have been developed, one of which is restorative covering agents or surface sealants.⁵ Surface sealant materials are able to enter into microgaps and microfracture and fill the irregular surfaces that formed during polymerization process. This material and it reduces the number of microleakage increases surface luster, marginal sealing and wear resistance.^{5,7} The usage of surface sealants may also reduce the roughness of the surface of the composite resin which might be the cause of microleakage.⁸ Previous research has

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suggested that the provision of surface sealant to margins in the enamel parts using Dura Finish®, Adper Scotchbond®, Helioseal®, Optiguard®, Seal-n-Shine® and Biscover® is able to reduce the level of microleakage.⁹

In recent years, researches have been developed flowable composite resins as a surface sealant materials.^{5,10,11} Flowable composites have bond strength and sealing ability, which is similar to fissure sealant. Besides, this material has a better mechanical property than fissure sealant materials.^{12,13} Surface sealant uses filler nanofilled/unfilled composite materials, and it could reduce the level of microleakage on composite resin.⁵

Nanohybrid flowable composites have suitable physical properties for surface sealant materials usage.⁸ The low viscosity of nanohybrid flowable composite causes this material to fill microgaps better than conventional composite.¹⁴ The nanohybrid composites also have a low marginal microleakage level and a good wear resistance.¹⁵ The aim of this study is to determine nanohybrid flowable composite resins as a surface sealant on microleakage score in composite resin restoration, compared with no surface sealant.

Materials and methods

Samples were collected by using selective random sampling technique. The sample used was the first maxillary premolar (n = 16) extracted for orthodontic treatment needs without enamel fracture and caries criteria.⁶ The samples were divided into 2 groups: group I, teeth were filled with packable ZT 350XT (3M ESPE®) without surface sealant (n = 8); and group II, teeth were filled with packable ZT 350 XT (3M ESPE®) and coated with nanohybrid flowable ZT 350 XT (3M ESPE®) as surface sealant (n = 8).

Teeth preparation

The permanent premolar teeth were cleansed with ultrasonic sculler, pumice, and rubber cup; it was then dried. The teeth were soaked in saline solution with 0.9% of sodium chloride content. The teeth were dried and fixed using red wax. The occlusal area was prepared forming a first class preparation with 2 mm depth and 2 mm wide of cervical occlusal. The preparation was executed by using cylindrical diamond bur.

Pre-prepared teeth were dried, and 37% phosphoric acid gel was applied for 30 seconds, and it was washed and dried. Bonding agent (Universal bond, 3M®) was applied using a single layer microbrush on the surface of the dentine and enamel. Bonding agent was dried and polymerization was executed by using light-cure-unit (Woodpecker LED-B, China) for 20 seconds.

The packable restorative material ZT 350 XT (3M ESPE®) was applied in group 1. The curing process was executed for 20 seconds then the restoration was polished and smoothed. The surface sealant material that uses a nanohybrid flowable composite ZT 350 XT (3M ESPE®) was applied in the group II. The area was then pulverized with water spray to flatten the flowable composite layer, then the curing process was executed by using a light cure unit for 20 seconds.

The teeth were stored in aquades solutions by using incubator at 37°C for 24 hours to prepare the teeth for dyeing application process. The apical foramen areas were closed by using a melted adhesive wax. The teeth were immersed in 0.5% of methylene blue solution for 24 hours at 37°C in the incubator with the occlusal side position of the teeth were touching the bottom of the petri. The entire sample was washed with aquades to remove the dye from the sample surface. The sample teeth were cut in the labio-lingual direction in the middle of the restoration of the occlusal part by using a carborundum disc bur. The results preparations were fixed in red wax to prepare it as the preparations for measuring the results of micro leaks using a digital microscope.

Dye Leakage Score

The images were captured by using digital microscope with 40x magnification to analyze the dyeing penetration at the marginal seal.^{10,16} The process was performed by two different observers to reduce subjectivity.¹⁷

Scoring criteria

0 – No dye penetration.

1 – Dye penetration up to 1/3 of the depth of the fissure.

2 – Dye penetration more than 1/3 and less than 2/3 of the depth of the fissure.

3 – Dye penetration more than 2/3 of the depth of the fissure.

4 – Dye penetration to reach the entire axial wall.

5 – Dye penetration to cover the entire cavity base.

Results

Scoring results from Group 1 and Group 2 are shown in Figure 1 and 2. The measurement of the microleakage of composite resin restoration without surface sealant has a score more than the one with surface sealant. The mean score of Group 1 is 1.75 ± 0.834 and median score is 4; whereas the range is between 3 and 5. The mean score of Group 2 is 1.125 ± 0.353 and median score is 1; whereas the range is between 1 and 2. The Mann-Whitney test results for both groups showed significant differences between Group 1 and Group 2 with p value = 0,000 ($p < 0.05$).

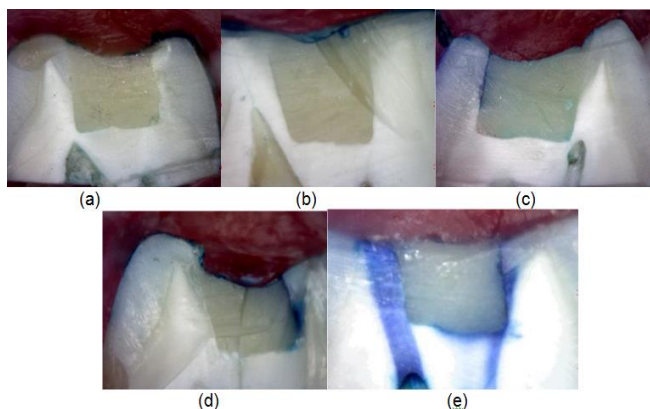


Figure 1. Dye penetration scoring, score 1 (a), score 2 (b), score 3 (c), score 4 (d), score 5 (e).

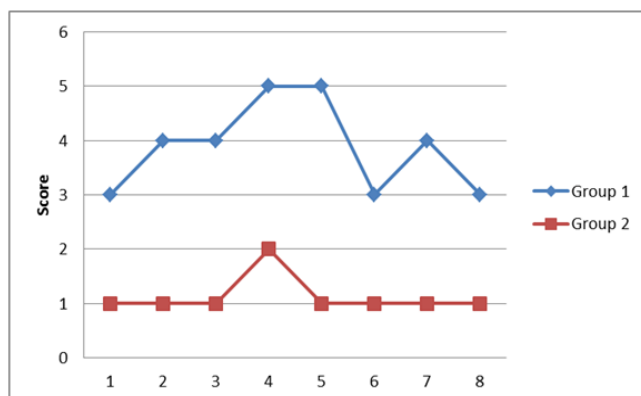


Figure 2. Scoring result in Group 1 and Group 2.

Discussion

Composite resins are widely used materials in the restorative dentistry field. Composite resins have good aesthetics properties and are directly bonded to the teeth without removing any healthy tissue.¹⁸ In addition to the advantages of the composites, it has a

deficiency in polymerization processes that lead to polymerization shrinkage. Shrinkage that occurs in the composite is about 1.35% to 7.1% but most materials are in 2-3%.¹⁹

Polymerization shrinkage could cause microgap formation.¹⁷ Microgap will cause the infiltration of ions, liquids, and microorganisms between the restoration materials and cavity walls known as microleakage.⁵ Microleakages cause damage to marginal adaptation. This is reported to be a major cause of restoration failure since optimal marginal seals are important factor in longevity of the restorations.²⁰ Therefore it is necessary to perform a microleakage test to evaluate the sealing ability of a material.²¹⁻²³ Microleakage tests that use dye penetration is one of the commonly used method, it is easy to apply and has reliable result.^{5,10,16,21-23}

Microleakage can be prevented by using appropriate preparation technique and proper material selection.²⁴ Surface sealant is a material that can be used to reduce the level of edge leakage.⁵ Surface sealant has a primary function in closing the microgap that leads to form on the restoration surface.²⁵ In this study, the flowable composite is used as a fissure sealant seeing that the nature of resin's low-viscosity could penetrate deeply into microgaps into surface microdefects.^{8,9} However a good surface sealant needs to meet several criteria such as low viscosity, low contact angle, high wetting properties, and having surface tension equal to or less than the critical surface tension of the restoration.^{5,8,9,26}

Polymerization shrinkage is affected by elastic modulus of composite resins, volumetric polymerization shrinkage, adherence of the composite resin to cavity wall, and cavity configuration factor (C-factor). C-factor is defined as a ratio of the bonded to the unbonded surface area.²⁷ Class I cavity is used in this study and it has a large C-Factor value; 5. The higher the C-factor, the higher the shrinkage loading on the tooth-resin interface. This will cause debonding on one or more restoration walls.²⁸ Previous research stated that there is rarely any research which discusses the level of microleakage in class I restoration; whilst in class I restoration, the probability of leakage due to polymerization shrinkage is quite high.²⁹

The level of microleakage in the restoration that possesses surface sealant is lower than the restoration of the remaining that

does not possess the surface sealant. This occurs in the group II because there is a low viscosity surface sealant coating; and it allows the nanofiller from the surface sealant to infiltrate into the micro gap that formed on the surface of the restoration through capillary style.⁹ The result of this study is in accordance with the previous research, which states that the flowable composite resin as a sealant surface is capable of eliminating the microleakage well.^{26,30} This is in contrast to other studies suggesting that not all low viscosity resin systems could be used as surface sealants seeing that not all low viscosity resin systems have high wetting properties.³¹ At last, the ZT 350 XT (3M ESPE®) nanohybrid flowable composite product is able to reduce the edge leakage.

Conclusions

The composite resin restoration's microleakage after coated with nanohybrid flowable composite as surface sealant is smaller than composite resin restoration only.

Declaration of Interest

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