Influence of a Dual-Cure Composite and Resin-Modified Glass Ionomer Cement used as a Dentin Substitute on the Microleakage of Class II Open-Sandwich Restorations.

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Abstract

Aim: To evaluate the influence of a dual cured composite and resin modified glass ionomer used as a dentin substitute on the microleakage of Class II open-sandwich restorations

Materials & Method: Standardized Class II cavities were prepared on 50 extracted human third molars. The teeth were randomly assigned to two groups (n=20) to compare a dual cure composite (Core X. flow) with resin-modified glass-ionomer cement (Vitremer) in open sandwich restorations covered with light cure composite (Ceram.X duo+). The teeth were then subjected to thermocycling (5 to 55 degrees, 500 cycles) with a dwell time of 15 seconds in electronically maintained water baths. The specimens were sealed with sticky wax at the root apices. Teeth were coated with two layers of nail varnish, leaving 1.0 mm around the margins of the cavity. Samples were immersed in 2% methylene blue solution for 24 hrs. The teeth were sectioned longitudinally and dye penetration was directly measured using stereomicroscope. Kruskal-Wallis and Mann-Whitney U test was applied to see the significance of mean of dye leakage.

Results: The degree of leakage increased significantly with Core X. flow compared to Vitremer. The resin-modified glass-ionomer cement remained the best intermediate materials when open-sandwich restorations are indicated.

Keywords: Core X. flow, Vitremer, Open-Sandwich technique, Dye leakage.

Introduction

With advances in dentine adhesives and the evolution of esthetic dentistry, resin composite materials are progressively being used as alternatives to amalgam in class II cavities in posterior teeth.[1,2] While class II composite restorations can be placed at an acceptable standard if the gingival margin is in sound enamel, there has been much debate regarding the marginal integrity of composite restorations that extend apical to the cementoenamel junction (CEJ).[3] Several in vitro studies have shown that there is poor marginal adaptation and considerable leakage when the cervical margin is located at or below CEJ.[2] This is due to the fact that dentin and cementum have higher organic content than enamel and are thus less favourable substrate for bonding.[4] In order to overcome the inherent disadvantages of composites, such as polymerization shrinkage and weaker adhesion at the composite-dentin interface several strategies were proposed. The step by step incremental technique, transparent

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matrices, light reflecting wedges and improved adhesive systems solved these problems only partially. Thus, a slightly different approach - an open sandwich technique was proposed. An open sandwich technique consists of a cervical layer of another class of material prior to composite insertion in class II cavities.

Glass ionomer cements have been proposed to be used as dentin substitute in case of open sandwich restorations due to its properties such as fluoride release and bonding to tooth structure.But, conventional GICs failed in open-sandwich restorations due to partial or total dissolution. This resulted in the use of RMGIC as base material. Vitremer, a tri-cure glass ionomer system overcomes the disadvantages of light cured glass ionomers while maintaining all their advantages. Studies investigating Vitremer in sandwich-technique have reported significantly better marginal adaptation on cervical dentin compared to base or total bond composite restorations.[5]

Another recent approach in sandwich technique is the use of dual-cured composite beneath composite restorations. Dual-curing composites may present a good alternative to RMGIC in open sandwich restorations and act as a dentin substitute. Core.X Flow, a recently introduced dual-cure composite have an advantage over light curing composites that, it can be placed in bulk like RMGIC, circumventing all the clinical problems related to light-curing. Moreover, it was reported that flowable materials, such as dual-cure composites, may improve the marginal and internal adaptation of composite restorations.[6,7,8,9] Very few studies have evaluated the effect of dual cure composites as dentin substitute in class II open sandwich technique.

Therefore, the purpose of this study is to evaluate the influence of a dual-cure composite (Core.X Flow; Dentsply De Tray, Konstanz, Germany) and a resin-modified glass ionomer cement (Vitremer; 3M ESPE, St. Paul, MN, USA) used as a dentin substitute on the microleakage of Class II open-sandwich restorations.

Methods & Material

Fifty non-carious, impacted human third molars were obtained and any residual soft tissue was carefully removed with the help of ultrasonic scaler and teeth were carefully examined under light microscope to rule out any pre-existing cracks. The teeth were then stored in 1% chloramine T at 4°C until use.

Specimen Preparation

A standardized mesio-occlusal class II cavity was prepared on each tooth using a straight fissure bur in a high speed handpiece. A new bur was used after every five preparations. All the internal line angles were rounded. The overall dimensions and depth were standardized as follows: occlusal floor - width 4 mm, length 5 mm; axial wall - width 4 mm, height 3 mm; gingival floor - width 4 mm, depth 2 mm. The proximal boxes ended in dentin 1 mm below the cemento-enamel junction (CEJ). The teeth were then stored in saline.

Forty teeth were assigned to the experimental group, and ten to the control group. Teeth in the experimental group were divided into Group I and Group II of twenty teeth each (n=20). Group III (n=5) -negative control. Group IV (n=5) -positive control.

Cavity Restoration

Group I: Core. X Flow

This group consisted of 20 samples. The

cavity was etched for 15 seconds and then rinsed with water from 3-way syringe and gently dried using a moist cotton pellet. The intensity of QTH was set at 500mW/cm² and was verified with the built-in radiometer. Dentin bonding agent, XP Bond with Self-Cure Activator, was applied with a fresh applicator tip to all the surfaces of two-third (2 mm) of cavity. Solvent was evaporated by thoroughly blowing with air from an air syringe for at least 5 seconds. Then it was light-cured for 10 seconds. A universal Toffelmire metal matrix band/retainer was placed around each prepared tooth and was supported externally by low-fusing compound to maintain adaptation of the band to the cavity margins. Dual cure composite (Core.X flow) was then used in bulk to fill the cervical two-thirds of the cavity. The material was visible light-cured for 20 seconds at an intensity of 550 mW/cm²and then allowed to be self-cured for 2-3 minutes. Excess material beyond 2 mm of the cavity was removed with the diamond bur. Etching and bonding was done for rest of the cavity as described above. The last coronal third was filled with a light-cured composite (Ceram.X duo+) using an incremental technique and cured for 40 seconds at an intensity of 500mW/cm².

Group II: Vitremer

This group comprised of 20 samples. Vitremer Primer was applied to the two-third of cavity for 30 seconds, the primer was dried using an air syringe for about 15 seconds and then it was light-cured for 20 seconds. A universal Toffelmire metal matrix band/retainer was placed around each prepared tooth and was supported externally by low-fusing compound to maintain adaptation of the band to the cavity margins. Vitremer was then used in bulk to fill the cervical two-third of the cavity. It was light-cured for 40 seconds and then allowed to self-cure for 4 minutes. Excess material beyond 2 mm of the cavity was removed with the diamond bur. Etching was done and bonding agent was applied on rest of the cavity as done for group 1. The last coronal third was filled with a light-cured composite (Ceram.X duo+) using an incremental technique and cured for 40 seconds at an intensity of 500mW/cm².

Ten additional teeth were restored, similar to those of group I, and were used as control.

Group III: Negative control

This group consisted of 5 samples, the teeth were restored same as group I.

Group IV: Positive control

This group also consisted of 5 samples, the teeth were restored same as group I but did not receive any dentin-bonding agent between the dentin walls and Core.X flow.

All the specimens (Group I, II, III and IV) were then stored in distilled water in an incubator at 37°C for 24 hours. The teeth were then subjected to thermocycling (5 to 55 degrees, 500 cycles) with a dwell time of 15 seconds in electronically maintained water baths.

Methylene Blue Penetration Test

The specimens were then sealed with sticky wax at the root apices. Teeth of experimental groups and positive control group were coated with two layers of nail varnish, leaving 1.0 mm around the margins of the cavity. Teeth of negative control group were entirely covered with nail varnish, not leaving 1.0 mm around the margins of the cavity. The teeth were then immersed in 2% methylene blue dye solution for 24 hours at 37 °C. After removal of the specimens from the dye, they were thoroughly rinsed in tap water. The teeth were then sectioned longitudinally along the mesiodistal plane cutting through the center of the mesial cavities using a low speed diamond disc. Scoring Criteria 0= no dye penetration,1= dye penetration up to one-third cavity depth,2= dye penetration one-third to two-third cavity depth,3= dye penetration in excess of two-third depth,4= extensive dye penetration involving the axial wall. The dye penetration at the tooth-restoration interface was observed under a stereomicroscope at a magnification of 20X (Olympus, Spectro Analytical Laboratory, Delhi). The results were tabulated and statistically analyzed. The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The mean, standard deviation, minimum and maximum values were calculated for all groups in terms of dye leakage. Descriptive statistics have been calculated for all the variables. Kruskal-Wallis and Mann-Whitney U test was applied to see the significance of mean of dye leakage. p-value of ‹ 0.05 has been considered as statistically significant level.

Results

Table 1 show the mean and standard deviation of dye penetration in all the groups.Dye penetration was significantly higher (p= 0.009) in group I, which was restored with Core.X flow, compared with group II, which was restored with Vitremer. The negative controls did not show any dye penetration and high penetration was observed in the positive controls.

Table 1: Mean ± SD and statistical comparison of dye leakage score

Groups	Dye Leakge Scores		Statistically significant difference between the groups			
	N	Mean±SD	I	II	III	IV
I	20	2.05±1.00	-	0.009	<0.001	0.001
II	20	1.10±1.02	-	-	0.024	<0.001
III	5	0±0	-	-	-	<0.001
IV	5	4±0	-	-	-	-

p-value <0.05-significant

Discussion

The greatest limitation in the use of composite restoration as a posterior restorative material seems to be shrinkage during polymerization, which leads to poor marginal seal and microleakage.[10] This problem is more conspicuous when the gingival margins of the tooth preparation lie below the cemento-enamel junction. Microbial microleakage, an important sequel of polymerization shrinkage has been identified as a major factor in the pulpal reaction to composite resin restorations.[11]

Several techniques have been developed in an attempt to reduce polymerization shrinkage stress, and to improve marginal adaptation. These include incremental composite placement, stepped or ramped light curing and open-sandwich technique. The open-sandwich technique for placement of class II posterior composite restoration has all layers of restorative material exposed to an oral cavity at the proximal margins, which are areas of primary concern for long-term clinical success.[12,13,14,15]

In the “open sandwich” technique, glass ionomer cement (GIC) is used as a dentin replacement in a laminated GIC/composite resin (CR) restoration. GIC adheres chemically to dentin and has a similar expansion coefficient to that of tooth structure.[16] But, the traditional open-sandwich technique with a conventional GIC showed clinical failure rates between 13% and 35% after 2 yrs and 75% after 6yrs (Welbury, 1990; Knibbs, 1992; van Dijken, 1994). The main reasons for failure were partial or total dissolution of the GIC part or fracture of the restoration.

Resin-modified glass-ionomer cements (RMGIC), introduced in the early nineties, showed improved mechanical and physical properties compared to the conventional cements and higher resistance to early moisture contact and desiccation.[17] One of the popularly used RMGIC is Vitremer. It has several advantages as compared to light-cure glass-ionomer restorative like bulk placement and adhesion to dentin in the absence of light. Several in vitro studies have reported less microleakage in Vitremer as compared to all other materials tested.[18,19]

Dual-curing composites may present a good alternative to RMGIC in open-sandwich restorations and act as a dentin substitute. Core.X flow, a recently introduced dual-cure composite is used in the present study.[8,20]

The results of this in vitro study showed that Core.X flow (group I) showed significantly more dye penetration as compared to Vitremer (group II).

The better dye penetration score of Vitremer might be due to its ability to absorb some of the polymerization stresses of the composite resin setting, reducing the stress accumulation in the dentin-restoration interface and water sorption which relieves setting shrinkage as compared to composites.[21]

The intrinsic porosity of this material, introduced by hand mixing, can increase the “within-material” free surface area, which also contributes to stress relief.[19,22]

The present findings are in accordance with the results of Koubi et al (2010)[21,23] who reported that Fuji II LC (RMGIC) demonstrated less dye leakage as compared with Multicore Flow (dual-cure composite) in a Class II open-sandwich restoration.

However, findings contrary to the present study was reported by Kamath et al (2012)[24] who found that delayed light polymerization of the dual-cured composite base reduced the microleakage in class II open-sandwich restorations.

The present study focuses on one of the major factors responsible for the clinical failure of Class II composite restorations, that is, microleakage. Further clinical studies are required to assess the clinical efficacy of dual-cure composites as dentin substitute in Class II open-sandwich restorations.

Conclusion

Within the limitations of the present study, it was concluded that

- Vitremer (RMGIC) when used as dentin substitute provides better marginal seal than Core.X Flow (dual-cure composite) in Class II open-sandwich restorations.

Further clinical studies are required to corroborate the findings of the present study.

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