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Effect of Various Resin Cements as Liner on the Microleakage of Restored Composite Class II restoration Using Closed Sandwich Technique

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ABSTRACT

Aim: Gingival margins of posterior composite restorations is usually more apical compared to CEJ. The present study was aimed to determine the microleakage in gingival margins of Class II composite restorations through using three different types of resin cements as liners.

Materials and Methods: In this *in-vitro* study, two mesial and distal Class II cavities with 1mm gingival margins were created under CEJ on 24 healthy human premolar teeth. The teeth were randomly divided into four groups: Group 1: Rely X Unicem liner, Group 2: PAN F2 liner, Group 3: RMGI liner, and Group 4: the control group where no liner was used. Then, teeth were restored using SE bond and Z-250 composite. The teeth were placed in 2% fushin solution after 24 hours of thermocycling. Then, the teeth were cut mesiodistally in order to analyze the microleakage under stereomicroscope. Statistical data were analyzed at significance level of 0.05 using SPSS version 16 by Kruskal-Wallis and Mann-Whitney statistical tests.

Results: Microleakage of cavities in experimental groups were significantly different ($p<0.05$). Groups 1 and 3 had significantly lower microleakages compared to group 2 ($p<0.05$). However, these two groups had no significant difference with each other ($p=0.590$).

Conclusion: Placing liner in posterior composite restorations reduced microleakage significantly compared to the control group. RXU and RMGI cements had similar effects on reducing microleakage and had significantly lower microleakage than PAN F2 cement.

KEY WORDS: Microleakage, Liner, Composite, Resin Cement.

1. INTRODUCTION

Application of posterior composite restorations has increased over the past decades due to some advantages such as beauty, no use of mercury, the ability to strengthen the remaining tooth structure, the increase of the fracture resistance of the restored teeth and conservative cavity preparation. Moreover, the patients demands for such restorations and replacement of amalgam posterior restorations with composite has increased (Castillo-de Oyague, 2012).

Despite recent advances, one of the disadvantages of composites refers to microleakage in the restoration margins and penetration of bacteria, fluid and molecules in tooth-restoration interface, especially in Class II restorations where restoration margins end on dentin. Microleakage can result in hypersensitivity, secondary caries, pulp stimulation and marginal discoloration (Ozel and Soyman, 2009).Therefore, microleakage is considered as an important factor in the evaluation of the clinical success of composite restorations (Powell, 1994).

Some the techniques that have been proposed to solve this problem include: composite layering placement, using wedge and transparent matrix, using auto-polymerizing composite, soft start curing methods and sandwich technique. In sandwich technique, an interstitial layer has to be placed between tooth and restorative material to reduce the marginal gap (Hagge, 2000).

The use of RMGIC (Resin Modified Glass Inomer Cement) is recommended in the sandwich technique due to bonding to tooth structure, and since it has special properties including the bacteriostatic feature, thermal expansion coefficient similar to that of enamel and dentin, and low hardening reaction and low shrinkage. Moreover, it may increase restorations'quality and longevity due to the improvement of mechanical and physical properties compared to conventional glass ionomer (Kasraei, 2011; Van Dijken, 1999).

Nowadays, resin cements not only improve the adherence of dental restoration but also have lower solubility and less microleakage in the oral environment compared to other types of cements (Gerdolle, 2008; Behr, 2004). Although, these cements are initially manufactured for cementation crowns, inlays and onlays by, studies have been conducted on their potential to be used as cavity liners for reducing leakage. Accordingly, Al-Saleh (2010), showed that self-adhesive resin cements have less microleakage in dentin compared to SBMP (Single Bond Multi-Purpose) and other types of resin cements.

Self-adhesive resin cements have low technical sensitivity and less operating time and are partially filled and it is expected that they have better mechanical properties compared to self-etch bonding agents. Their adhesion mechanism is due to the acidic monomer in their composition which penetrates into the demineralized collagen network (Stawarczyk, 2011). In addition to the thicker tooth-cement-composite bonding compared to tooth-bonding-composite and thus a higher potential to cope with the forces that cause shrinkage, it causes a better distribution of stress between the interfacial layer, dentin and composite (Al-Saleh, 2010). With regards to the increasing production of various types of resin cements and the importance of microleakage in dentin margin of Class II composite restorations, the aim of this study was to determine the effect of resin cements and resin modified glass ionomer as liners on the microleakage of class II composite restorations.

2. MATERIALS AND METHODS

In this *in vitro* experimental study, 42 sound human maxillary premolar teeth were selected. The teeth were devoid of any cracks, caries, and previous restorations, and were extracted for orthodontic reasons in the 3 previous months. The teeth were placed in 10% formalin for disinfection for 48 hours. They were stored in distilled water until experiment time after removing the debris and soft tissue by periodontal scaler. In each tooth, two Class II holes were made, one in distal and the other in mesial, with gingival margins on dentin (1mm below CEJ) and buccolingual width of 3mm, occlusal and gingival height of 6 mm and axial depth of 1.5 mm by a 245 fissure bur (Diatech-Scissdertal-Switzerland), turbine, and water and air cooling. Line angels were included by #1.2 tungsten carbide bur (SS White, Great White Series, Lakewood, NJ, USA) in the process. No bevel was prepared in the cavity. A new bur was used after preparing every 5 teeth. The dimensions of the cavity were reviewed by periodontal probe once again. If the prepared cavity was smaller than the desired size, the cavity was expanded. If the cavity was larger than the specified dimensions, samples were excluded from the study.

The teeth were divided randomly into 4 groups with 12 cavities: The metal automatrix (Kerr Hawe Adapt Super Cap Matrix, Kerr Hawe SA, Bioggio/Switzerland) was fixed around the tooth and it was supported by wax adhesive (Sticky Wax Model Cement-500G, Associated Dental Products Ltd, Swindon, SN5 4HT UK) to increase compliance section.

Then, the groups were restored as follows:

Group 1: Rely X Unicem cement (3M ESPE, Seefeld, Germany) was placed as instructed by the manufacturer in a thin layer by a microbrush in gingival floor and axial wall. All cavity walls were treated by Self-etch primer bonding (Clear fill SE bond, Kurary, Japan) according to the manufacturers' instructions and cured by Demi LED Light Curing System (Kerr Corp, Orange, CA, USA) for 20 seconds. Then, A2 Z-250 composite was placed in four distinct layers. First layer was placed horizontally with a thickness of 1mm and next layers were placed diagonally in thickness of 2mm and each layer was cured for 20 seconds. Finally, occlusal surface was shaped by Football Multi Fluted carbide bur (Diatech-Scissdertal-Switzerland) with water and air cooling.

Group2: It was treated like Group1, but PAN F2 (Panavia-F 2.0, resin cement with Self-etch primer, Kurary Dental Co, Okayama, Japan) resin cement was used instead of RXU.

Group3: It was treated like Group1, but RMGIC (Fuji II LC, GC Corporation) was applied instead of RXU.

Group4: It was considered as control and no liner was used in the cavity and cavities were restored by Z-250 composite and Self-etch primer bonding system (Clear fill SEbond, Kurary, Japan) according to the manufacturers' instructions.

The restored teeth were stored for 7 days in 37ºC distilled water in incubator (Thermo scientific Heraeas microbiological incubator, Loughborough, UK). Then, the teeth were thermocycled in a thermocycling device under thermal cycles of 1000 cycles between 5ºC-55ºC with 30 seconds dwell time in each water bath and 15seconds transfer time between each thermocycle bath.

After thermocycling, two layers of varnish was applied on the coronal surface of the teeth, 1mm away from restoration margins and the apex of teeth were sealed by wax and samples were immersed for 24 hours in 2% fushin solution at a temperature of 37ºC. Then, they were washed under water tap for 5 minutes.

The samples were cut into two equal parts in mesiodistal direction bymetal discs (Diamond discs, Axis Dental Company, Sybron Endo, USA) and sufficient water spray in order to examine microleakage.

The samples were observed under a stereomicroscope (PZO, Warsaw, Poland) with a magnification of 40 times.

Dye penetration into the restoration interface was classified through 5 scales as:

0: No dye penetration

1:Dye penetration up to the outer half of gingival floor

2:Dye penetration up to the inner half of gingival floor

3: Dye penetration passed into gingival floor and penetrated into two third of axial wall.

4: Dye penetration into axial wall completely and extent of DEJ.

For data analysis, non-parametric Kruskal-Wallis test and Mann-Whitney complementary test were used at significance level of 0.05.

3. RESULTS AND DISCUSSION

The results of Kruskal-Wallis test showed that there are meaningful statistical differences between the groups (P=0.000).Table1 shows pairwise microleakage comparison between the groups based on Mann-whitney test. Accordingly, Group1 in which RXU liner was used showed the lowest microleakage, but it had no meaningful difference with group 3 in which RMGIc liner was used.

Table.1. Pairwise comparison of microleakage among the understudied groups using Mann-Whitney Test

Groups	P.Value
Group 1(RXU) and Group 2 (PAN F2)	0.005
Group 1(RXU) and Group 3(RMGIc)	0.590
Group 1(RXU) and Group 4 (Control)	0.000
Group 2 (PAN F2) and Group 3(RMGIc)	0.005
Group 2 (PAN F2) and Group 4 (Control)	0.011
Group 3(RMGIc) and Group 4 (Control)	0.000

Microleakage of composite restorations due to the stress in the tooth-restoration interface is affected by polymerization shrinkage, temperature fluctuations in the mouth and mechanical fatigue caused by periodical chewing forces in which the most important reason can be the polymerization shrinkage towards stronger enamel-composite bounding and light source. This microleakage can result in restoration sensitivity, recurrent caries and consequently, restoration replacement (El-Mowafy, 2007). Therefore, some methods have been proposed to reduce this microleakage such as oblique composite layering placement to reduce shrinkage and stress between tooth and restoration in order to reduce microleakage by reducing the volume of cured material and c-factor at the same time. In the present study, the researchers used oblique composite layering placement method which was described by Taylor and Lynch (1992).

Dye leakage, using color highlighter for micro-organisms, radioactive isotopes, using air pressure, neutron activation analysis, electrochemical studies, using scanning electron microscopy, thermal and mechanical cycles and chemical tracers are considered as different techniques to determine microleakage (Agrawal, 2012). Since the gold-standard method has not been introduced to examine microleakage, dye leakage method was used in this study because it does not require complicated laboratory equipment, it is a non-destructive method, and makes the longitudinal studies on the restoration margin possible (Alani and Toh, 1997).

Studies are suggested to use a dye which its size equals to or is smaller than the size ofbacteria (about 2 microns), thus, the 2% fushin solution was used with particle size smaller than bacteria (Yavuz and Aydin, 2005). Storing time for dye penetration differs from 10 seconds up to 180 days. However, 24-hour penetration time is used in most research papers to specify our research (Al-Saleh, 2010).

Closed sandwich technique was used in this study which had a higher clinical success. High solubility of liners particularly RMGIc that is exposed to the oral environment, higher level of abrasion, and lower physical properties are disadvantages of open sandwich technique compared to close (Kasraei, 2011).

In this study which was aimed to determine the microleakage of composite restorations using liner, Kruskal-Wallis test showed that all understudied groups have meaningful statistical differences with each other (P=0.000). Moreover, the complementary test showed that each of the groups has meaningful differences compared to the control group.

One of the reasons for the decrease of microleakage in groups having liner than the control group is decreasing composite mass volume and subsequent dimensional changes during polymerization (Yazici, 2003). Furthermore, the use of bonding on dentin surface causes forming a thin adhesive layer which has little capacity to absorb the stress of composite shrinkage and this could explain the more rate of microleakage in the control group (Kasraei, 2011).

Through pairwise comparison of understudied groups, it was observed that RMGIc and RXU Self-adhesive resin cements reduce microleakage significantly more than PAN F 2.0 Self-etch primer resin cement respectively and these two did not show any significant differences.

RXU requires no preparation of dentin. The formula contains multi-functional phosphoric acid methacrylate which has the ability to react with the surface of the teeth in a complex combination with calcium ion or different types of physical reactions such as hydrogen bonding or bipolar banding. These reactions enable RXU to bond to enamel and dentin and cause proper seal in tooth and show a small amount of microleakage (Piwowarczyk, 2005).In the present study, PAN F2 dual cured resin cement showed more microleakage compared to RXU and RMGIc which is in agreement with Piwowarczyk's research and may be associated with the shrinkage of the cement during polymerization (2005).

In addition, in direct restorations, resin cement resists the stresses induced by the shrinkage of composite layer on which it is applied (Al-Saleh, 2010). Different results are obtained by different mechanisms of cement adhesion to dentin. In PAN F2 cement, partial penetration of the resin monomers into the demineralized dentin surface forms areas in nano-scale, while RXU bounding to dentin via the phosphoric acid methacrylate, and possibly chemical reaction with ionized calcium of hydroxyapatite is the mechanism of adhesion to dentin (Inukai, 2012).

The present study showed that RMGIc also reduces microleakage greatly compared to the control group. Aboushala (1995), showed that RMGIc has high potential to reduce microleakage when used as a liner under composite restorations. Setting reaction of RMGIc is slow and has an amount of flow which reduces transferred stress to bond and less microleakage (Kim and Hirano, 1999).

Moreover, Mount (1998), described a ion-enriched layer created by displacing calcium and phosphate ions from apatite by liquid carboxyl group of Glass Ionomer and re-deposition of ions occurred between cements and tooth contour by glass ionomer setting.

Furthermore, Mitra (2009), reported an amorphous region which was similar to the hybrid layer as it seemed that they are of RMGIc products with dentin mineral material. In addition, RMGIc has a chemical bond by ionic reaction of the carboxyl groups of a polyalkenoic acid with ions of calcium hydroxyapatites that are attached to the collagen fibrils. The chemical bond makes excellent long-term bond, resistance to microleakage and the ability of this material for dentin seal (Dursun, 2013).

This *in-vitro* study was conducted on extracted teeth. However, in clinical conditions, other factors such as thermal, mechanical, chemical and fatigue stresses during function affect the durability and strength of bond. Although in the present study, thermal stress was applied to the samples by thermocycling, but future studies are suggested to simulate mouth condition in different aspects.

4. CONCLUSIONS

Placing liner in posterior composite Class II cavities reduced microleakage significantly compared to the control group. RXU Self-adhesive cement and RMGIc cement have similar effects on reducing microleakage and reduce microleakage more significantly compared to PAN F2 Self-etch Primer cement. RXU cement shows less microleakage compared to RMGIc cement, but the difference was not significant.

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