COMPARATIVE STUDY ON MICROLEAKAGE OF COMPOSITE INLAYS USING VARIOUS RESIN LUTING CEMENTS

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ABSTRACT

This study is conducted to compare two resin luting cements (Rely XTM ARC, 3M and Compolute™ ESPE) on their microleakage with one composite inlay system (Filtek™ Z250 Universal Restorative Materials, 3M). Thirty conventional inlays, Class II *MOIDO* cavity with gingival margin I mm above the cementoenamel junction, were prepared in premolar teeth. The composite inlays were fabricated directly on the prepared teeth using layering technique. Fifteen of the inlays were cemented with RelyTM X ARC and fifteen with Compolute™ (ESPE). The specimens were kept at 37° C for 10 days before thermocycling and immersed in methylene blue 2% solution for 24 hours. The teeth were sectioned mesio-distally. The site and degree of leakage of each section was scored using a visual scoring system under a stereomicroscope at a magnification of 1.5X. Results showed that there was no significant difference in'leakage extent (p>O.05), between Rely X™ ARC and Compolute™. For both materials, leakage occurred most commonly within the enamel surface and between the cement-tooth interfaces. None of the leakage occurred between inlay - cement interface. There is no significant difference in the extent of leakage between Rely XTM ARC compared to Compolute™.

Key words: composite inlay, microleakage

INTRODUCTION

Advances in dental composite techniques, combined with the ability to produce an aesthetic restoration that is bonded to tooth structure have lead to increased clinical usage of composite in recent years.

Despite improvements in the wear resistance of some of the new materials, problems remained with the use of direct composites especially in the Class II situation. Poor marginal adaptation and microleakage have been identified as problems at the cervical margins of Class II composites (1). Polymerisation shrinkage of the composite and poor adhesion of the material to cervical tooth structure has been implicated in this regard (2). Whilst the development of visible light cured composites has been of major benefit, the inaccessibility of deep confined proximal areas to the light curing source in the Class II situation creates the potential for poor marginal adaptation because of inadequate cure of the composite in the region (3).

Manufacturers have responded to these problems by introducing composite inlay systems, which utilized direct and/or indirect techniques. A high degree of post curing of composite inlays are assured before the restorations are bonded to the tooth and also the adverse effects of polymerisation contraction can be minimized (4). Post curing composite seems to be advantageous in terms of occlusal and proximal wear compared with direct applied resin base composite (5).

Currently, there are three main types of luting cements commercially available for composite or ceramic inlays; resin composite cement, polyacid-modified resin composite (compomer), and resin-modified glass-ionomer cement(RMGIC) (6).

According to the method of polymerisation, resin composite cements could be classified into three main categories: self cured cements, used mainly for cementation of metallic restorations and posts; light cured cements, used for cementation of porcelain veneers; and dual cured cements, used for cementation of ceramic inlay and onlay restorations, indirect resin composite restorations and ceramic crowns (7).

The advantage of using dual cure luting agents is to reduce the problems associated with inadequate polymerisation of composite resin in areas distant from the light source (3).

In addition to improvement in c;omposite systems and restoration techniques there has been a steady progress in treatments for bonding resins to tooth tissues. Some recently developed dentine bonding agents make use of conditioning liquids, which render the dentine amenable to bonding at the same time as etching the enamel, thus simplifying the resin bonding of a restoration. These dentine bonding agents are able to infiltrate into the etched dentin and form hybrid layer which may reduce microleakage (8).

OBJECTIVES OF STUDY

The objective of this study is to make a comparison on micro1eakage of two resin luting cements in a composite inlay system. The two resin luting cements were used because they have the same components as the composite inlay system. This will enable chemical bonding to form between the inlay and luting media. Each of the luting cement used a different primer system that was recommended by its manufacturer.

MATERIALS AND METHODS

Two resin luting cement namely Compolute™ (3M ESPE) and RelyX™ ARC (3M) were used with the universal composite FiltekTMZ250 (3M).

Preparation of specimens

Thirty extracted non-carious premolar teeth were stored in 0.5 % Chloramine at room temperature for one week and then stored in distilled water at temperature of 4°C. The calculus and soft tissue remnants were removed from the selected teeth using ultrasonic scaler. The teeth were randomly selected and separated into 2 groups of fifteen.

Group A - Cemented with RelyXTMARC (3M)

Group B - Cemented with Compolute™ (3M ESPE)

Restorative procedures

Each tooth was mounted on a plaster box for easier preparation of the cavity. Water-cooled high-speed handpiece with tapered fissure diamond burs (ISO 8036 314) was used to prepare conventional Class II (MO)/(DO) inlay cavities where the gingival floor of the cavity was placed about 1 mm above cementoenamel junction. All cavities were prepared in the dimension of 2.0 mm in width and 1.5 mm in depth *(Figure la & Ib).*
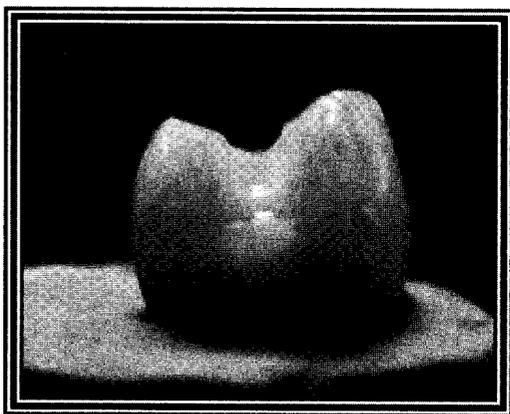
Fabrication of composite inlays

The composite inlay (Filtek Z 250, 3M) was constructed directly on the prepared tooth. A separating agent (Brilliant D.I Coltene Inc., Calf.) was applied to the cavity before the fabrication of these inlays. The composite (Filtek Z 250, 3M) was applied using layering technique whereby the proximal walls were added incrementally along the buccal and lingual surface and light - cured between the applications for 40 seconds to enhance the polymerisation reaction. The preparation border was marked with pencil for easier identification of margins. The cured inlays after being removed from the tooth preparation were trimmed of excess material using white stone burs (Shofu, Dura White Stone, Japan). The marginal adaptation was checked by running a sharp probe along the margins. These inlays were polished with Enhance® polishing paste (Enhance® Composite finishing & polishing system, Densply) according to the manufacturer's instructions. Prior to cementation, the fitting surfaces of the inlays were sandblasted with 50 *Jlm* aluminium oxide particles using Basic Professional Sandblaster (Renfert, D78247, Hilzingen, Germany).

Cementation of composite inlays

Fifteen of the inlays were cemented with resin luting cement RelyTMX ARC, (3M) and fifteen with Compolute™ (ESPE). Manipulation of the cement was carried out at room temperature following the manufacturer's instructions.

The test group

Group A - Cemented with Rely ™ X ARC (3M)

For Rely-X ARC (3M) group, the cavities were etched with 3MTMScothbondTMEtchant for 15 seconds. These were then rinsed thoroughly under running water for 10 seconds and dried with damp cotton pellet. Then 3MTMSingle Bond Dental Adhesive System was applied to etched enamel and dentine and dried for 5 seconds and light cured. Appropriate amount of Rely

Figure la

Figure lb

Figure la: The proximal box of the cavity preparation. Figure Ib: occlusal view of the cavity preparation.
Approximate size of the cavity - 2.0 mm in width and 1.5 mm in depth.

- X ARC resin cement was dispensed onto a mixing pad and mixed for 10 seconds. The mixed cement was allplied to the internal surface of the inlays using a small brush. The inlays were held in place by applying finger pressure via a burnisher at the centre of each inlay. Excess cement was removed from all surfaces with a cotton pellet and each surface was cured for 40 seconds using the visible light - cure unit (Coltene®, Coltlux 3). These inlays were than polished with Enhance® polishing kit (Enhance® Composite finishing & polishing system, Dentsply).

Group B - Cemented with Compolute™ (ESPE)

For Compolute™ (ESPE) the enamel and dentine were etched using the total etch technique (EBS® Multi). Etching was carried out for 15 seconds. This was then rinsed thoroughly under running water for 10 seconds and dab dry with cotton pellet. The primer (EBS® Multi Primer) and the bonding agent (EBS® Multi Bonding) were applied to etched enamel and dentine for 20 seconds without light - curing. Appropriate amount of Compolute™ resin cement was dispensed onto a mixing pad and mixed for 10 seconds. The mixed cement was applied to the internal surface of the inlays using a small brush. The inlays were held in place by applying finger pressure via a burnisher at the centre of each inlay. Excess cement was removed from all surfaces with a cotton pellet and each surface was cured for 40 seconds using the visible light - cure unit (Coltene®, Coltlux 3). Excess cement at the proximal surface was removed. These inlays were then polished with Enhance® polishing kit (Enhance® Composite finishing & polishing system, Dentsply).

Thermocycling procedure

Prior to thermocycling

Ten minutes after cementation the teeth were then stored in distilled water and kept at 37°C for 10 days before thermocyc1ing and were then immersed in the dye solution.

Thermocycling regime

Both groups were thermocycled for 500 times between 15°C and 45°C with dwell time 15 seconds in each bath (Neslab FTC-350, GP200, USA) and 5 seconds interval between them in the distilled water.

Evaluation of microleakage

Preparation prior to sectioning

After thermocyc1ing the specimens were taken out, dab dry with a tissue paper and the root apex sealed with sticky wax. The teeth were coated with a layer of nail polish while 1.0 mm of the margins of the restoration were kept free of any coating. The coated teeth were then immersed in 2 % methylene blue solvent for 24 hours. After removal from the dye, the coating was removed and the teeth were thoroughly washed in water and dab dry with tissue paper. The
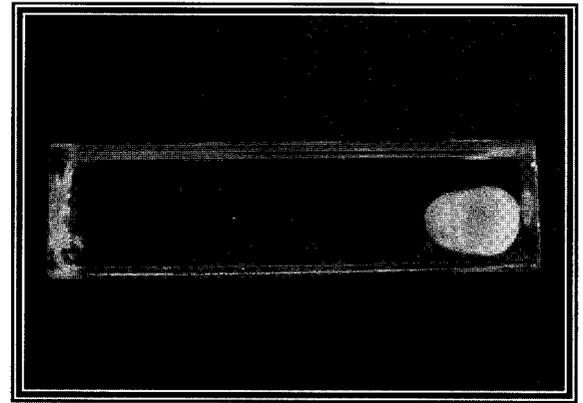

Figure 2: Specimen embedded in epoxy resin (Mirapox 950-230) in the plastic cuvettes (Dispolab Kartell) prior to sectioning.

roots were sectioned 3 mm below cementoenamel junction by using a straight handpiece with carborandum disc and embedded in the Epoxy resin (Mirapox 950-230) in the plastic Cuvettes (Dispolab Kartell) *(Figure 2)*.

Sectioning of specimens

The teeth were sectioned longitudinally in the mesio-distal plane at the mid line of the restoration. Sectioning of teeth were carried out by using low speed saw (Buehler, 11-1180 Isometa).

Microleakage evaluation procedure

Two halves of the specimens were viewed under a light stereomicroscope 15X magnification (MEIJI-Zoom Stereo EMZ-l 7613). The half that showed more leakage was chosen for evaluation. All specimens were examined three times for microleakage with a three day period between each evaluation. Each evaluation was carried out independently without reference to previous score. This was to eliminate evaluator's bias.

Criteria for microleakage evaluation

The site and degree of leakage of each section was scored using the scoring system as shown in *(Figure 3)*.

Data analysis

The severity of micro leakage data was subjected to statistical analysis by using Chi-Square test.

RESULTS

The dye penetration was subjectively scored using the scoring system as described in *Figure 3*.

Chi-Square Test showed that there was no significant difference in microleakage between the two resin cements (Rely X ARC and Compo lute) and the extent of leakage (p-value = 0.606,p>0.05). No leakage was observed in 46.6% of specimens using

0 No dye penetration

Dye penetration up to DEJ
entinoenamel Junction

2 Dye penetration *Y.* of dentin

3 Dye penetration up to the axial
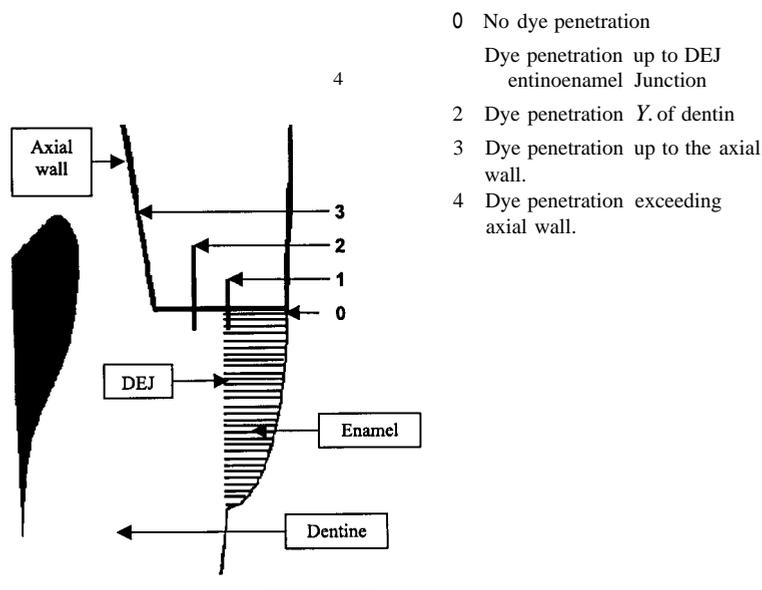wall.

4 Dye penetration exceeding
axial wall.

Figure 3: The site and degree of leakage of each section scoring system.

Table 1. Cross-tabulation   of extent of microleakage   at the gingival margin between Rely XTMARC and Compolute™

Materials	Leakage Score					Total
	0		2	3	4	
Rely XTMARC	7 (46.6%)	6 (40.0%)	1 (6.7%)	1 (6.7%)	0	15 (100%)
Compolute™	8 (50%)	6 (33.3%)	0	1 (16.7%)	0	15(100%)

Rely X™ ARC and   50.0%   of specimens   for Compolute'M *(Table 1).*

DISCUSSION

Consistency of the scoring was accomplished within the three evaluations of all the specimens. The inter-examiner calibration was 89%, giving a favourable indication of the consistency of evaluation. In this study, microleakage occurred in both groups (Rely XTM ARC and CompoluteT>I)Most of the leakage occurred at the cement - tooth interface. The pattern of leakage in this study showed that with Rely XTMARC *(Table* 1), 7 specimens   (46.6%) Scored 0 *(Figure 6a), 6* specimens (40.0%) Scored I *(Figure 6b),* I specimen (6.7%) Scored 2 and 1 specimen (6.7%) Scored 3. It showed that most of the leakage occurs at the enamel interface before the dentoenamel junction. Only two specimens   (13.4 %) showed leakage beyond the dentoenamel junction and none of the specimens had dye penetration beyond the axial wall. In Compolute™

the pattern of leakage seen was the same as Rely XTM ARC but the percentage of leakage is quite different *(Table* 1). In Compolute™group, 8 specimens (50.0%) Scored 0 *(Figure 7a),* 6 specimens (33.3%) Scored 1 *(Figure 7b)* and 1 specimen (16.7%) Scored 3. In this group also, none of the specimens showed that the dye had penetrated beyond the axial wall.

This showed that the margins of the inlays, when cemented with both resin luting cement were susceptible to leakage. Leakage was shown to occur at the cement-tooth interface in both cements. This observation is in agreement with the study done by Ferrari et al (9) who found that the margins of the restorations when cemented with resin cement were susceptible to leakage and occurred at the cement - tooth interface. This could be due to the fact that the resin luting cement shrinks on polymerisation, leaving a gap, which is large enough for the dye solution to penetrate. On polymerisation the direction of shrinkage is towards the centre of the cement lute. This will apply stress to both the cement interface and the cement-inlay interface. Depending on the quality of the
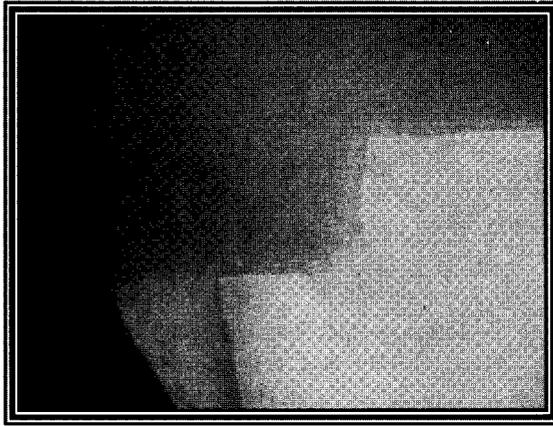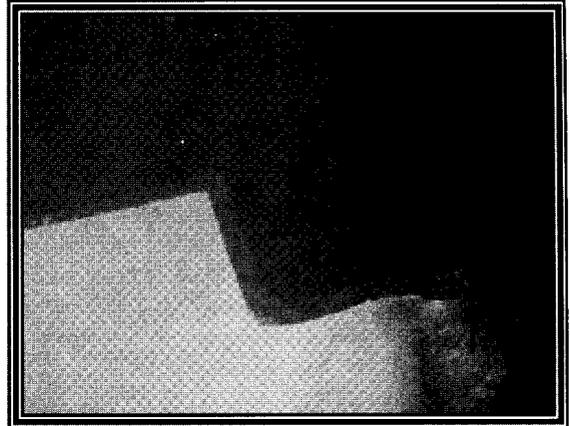
Figure 6a (Score 0)

Figure 6b (Score I)

Figure 6a & 6b: Rely""XARC, Score = 0 and Score = I.
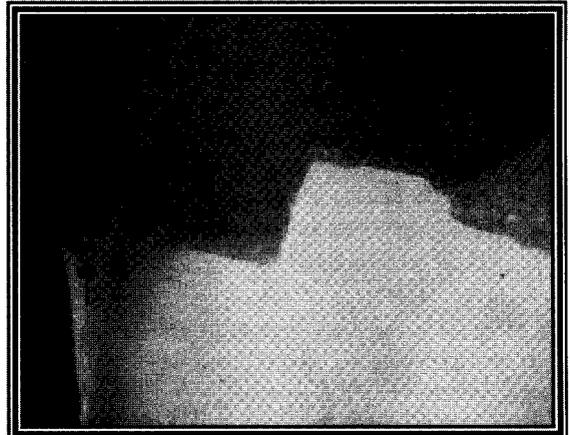

Figure 7a (Score 0)

Figure 7b (Score 1)

Figure 7a & 7b: Compolute™ Score = 0 and Score = 1.

bond at these two points, the stress applied may be sufficient to cause separation of the cement at either one or both of these interfaces. However in this study, none of the specimens showed leakage occurring at the cement-inlay interface. This observation is in accordance with the study by Alavi et al (10) who found that no leakage occurred at the cement - inlay interface. This could be due to chemical bonding between the composite and the resin luting cement or the surface was sandblasted to create a micromechanical retention (11) that prevented the separation between the inlay-cement layer and hence no micro leakage happened at this interface.

The result of this study provides supporting evidence that the gingival margins are the weakest bonding area of indirect composite inlay. This is in agreement with the study done by Robinson et al (12), Hasegawa et al (13) and Shortall et al (11). However, compared to results obtained with the oldest systems,

the superior sealing capacity of restorations which used these latest dentine bonding systems (EBS Multi and 3M ScotchbondTM Single Adhesive) can be attributed to the hybridisation of the conditioned substrate (14).

In this present study, even though the scoring is in accordance to the scoring system used, the statistical analysis showed there was no significant difference between Rely XTMRC and Compolute™ (p > 0.05) in the extent of leakage. But this result should be interpreted carefully since the number of sample in this study was quite limited (n= 15). Therefore, it was suggested that two scores should be applied which either "No leakage" or "Leakage" (which include scores 1,2,3) (Table 2). Chi-Square test was done and it was found that there was no significant difference in the presence or absence of leakage, between Rely XTMRC and Compolute™ (p> 0.05).

The finding of this study is in agreement with Alavi et al (10) who found that there was no significant

Table 2. Cross Tabulation of microleakage at the gingival margin of the cavity preparation between Rely XTMARC and Compolute™

Material	Score		Total
	(No Leakage)	(Leakage)	
Rely XTMARC	7 (46.7%)	8 (53.3%)	15 (100%)
Compolute™	8 (53.3%)	7 (46.7%)	15 (100%)

difference in the extent of leakage between several bonding systems and resin luting cements (including Rely XTMARC with 3M Scotchbond™Single Adhesive and Compolute™with EBS Multi).

CONCLUSIONS

For both materials, leakage occurred most commonly within the enamel surface. There is no significant difference in the extent of leakage between Rely X™ ARC compared to Compolute™.In both cements (Rely XTMARC and CompoluteT~ leakage occurred between the cement-tooth interface. None of the specimens had leakage occurring between inlay - cement interfaces.

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