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Original Article

Dentistry Section

Effect of Caries Detecting Dye on Microleakage of Composite Resin Restorations Bonded with Total-etch and Self-etch Adhesive Systems

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ABSTRACT

Introduction: Caries detecting dyes are solutions employed to differentiate the infected portion of carious dentin from the remineralizable affected dentin. However, it is important that these agents should not interfere with the adhesion of permanent restorative materials.

Aim: The purpose of this study was to evaluate the effect of caries detecting solution on microleakage of composite resin restoration bonded with two adhesive systems.

Materials and Methods: Class V cavity of standardised dimension was prepared on forty intact extracted molars. Out of this, 10 teeth each were randomly selected for the four study groups. Group 1: composite restoration after etch and rinse technique without any prior exposure to caries disclosing solution; Group 2: placement of the restoration as mentioned in group 1 after exposing the cavity with caries detecting solution; Group 3: cervical restoration with composite after the use of self-etch adhesive system, with no exposure to caries detecting dye; Group 4: Similar to group 3 except that caries disclosing agent was applied onto the class V cavity before the placement of the composite restoration. The amount of dye penetrated was evaluated using fluorescent microscope. The microleakage scores were recorded and data obtained were subjected to statistical analysis using the chi-square test.

Results: No significant difference was detected between the groups ($p>0.05$). However, Group 3 (self-etch without dye) showed the least percentage of microleakage with none of the restorations showing grade 3 leakage score.

Conclusion: All study groups showed microleakage, but there was no statistically significant difference between the leakage scores. However, the highest leakage was seen in the total etch group where caries detecting dye was used.

Keywords: Caries disclosing solution, Composite restorations, Dye penetration, Fluorescent microscope

INTRODUCTION

Dentistry has always been in a race to find the perfect restorative procedure and material. The success of a restoration depends on a number of factors. One of those factors is good marginal seal, preventing microleakage. Microleakage is the passage of bacteria, fluids, molecules or ions between tooth and the restorative material which cannot be detected clinically [1]. It is the main reason for failure of most restorations, especially posterior tooth-coloured restorations. It may result in postoperative sensitivity, marginal breakdown, secondary caries and pulpal pathology [2]. Thus, much effort and research are undertaken to reduce microleakage. The foremost reason for leakage at the restoration-tooth interface is residual caries.

A good restoration relies on the complete removal of caries. Many adjuncts have been introduced to achieve this task, including caries detecting dyes. Carious dentin can be separated into two layers [3]. The outer layer, known as infected dentin, cannot be remineralised and should be removed. However, the remineralisable inner layer, known as affected dentin should remain intact. Caries detecting dyes act by staining the outer layer of carious, soft dentin [4]. This helps in ideal cavity preparation, decreasing possibility of pulpal pathology and restoration breakdown.

When using composite resin restorations, there are two basic adhesive strategies followed. Either it could be 'etch and rinse' technique or it could be 'no rinse' technique. Both these techniques have their own advantages and disadvantages [5]. Though etch-and-rinse adhesives are considered as the gold standard for dental adhesion, it is technique-sensitive for adequate dentin bonding, because overdried dentin causes demineralized collagen fibres to collapse and reduce monomer diffusion among the collagen fibres. Self-etch adhesives on the other hand have the advantage of demineralizing and infiltrating the tooth surface simultaneously to the same depth, ensuring complete penetration of the adhesives. Self-etch adhesives are also associated with absence or lower incidence of postoperative sensitivity. However, laboratory and clinical data with self-etch adhesives have shown lower bond potential to unground enamel [6].

The basis of this study was to probe into the effect of caries disclosing solutions on microleakage of composite resin restoration bonded with two adhesive systems, that is, total etch and self-etch systems. The null hypothesis of this study was that, caries disclosing solution does not interfere with the bonding of composite resin restoration irrespective of the adhesive system used.

MATERIALS AND METHODS

This is an in-vitro study conducted on human molars after obtaining the Institutional Ethical committee clearance from Manipal College of Dental Sciences, Mangalore, India. The study was conducted in March and April 2018.

Sample selection and storage: Forty extracted human molars with no caries, wear defects, fracture line or cracks were included in the study. Surface debridement was done with hand-scalers, cleaning with a rubber cup applied with slurry of pumice, and was subsequently stored in distilled water at room temperature until use.

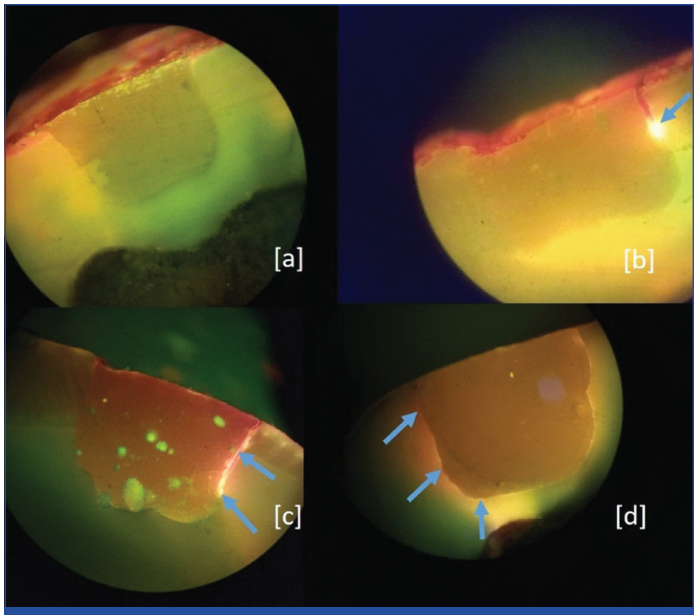
Sample preparation: Class V cavities, rectangular in shape (2 mm in occluso-gingival height, 4 mm in mesio-distal width and 2 mm in depth) were prepared with high-speed air-water cooled handpiece on the buccal side of extracted molars, using tungsten carbide straight fissure bur. Cavity preparations were located in the Cemento-Enamel Junction (CEJ), with the coronal margin in the enamel region, extending cervically to the cementum region. From the pool of forty teeth with class V cavities prepared, 10 teeth were randomly assigned to the four study groups.

Restorative procedure in each group: All the cavities were restored with composite resin Filtek Z350 XT (3M ESPE, St. Paul, MN, USA).

- Group 1 {Total Etch system (TE) without caries detecting dye}: The cavities were etched with 32% ortho phosphoric acid (Scothbond™ multipurpose etchant, 3M ESPE, St. Paul, MN) for 20 seconds. Following which the cavity was thoroughly washed with distilled water for 10 seconds and blot dried. Two coats of bonding agent (Adper™ Single bond 2, 3M ESPE, St. Paul, MN) was then applied, air thinned and cured for 20 seconds (Elipar 2500, 3M ESPE, St. Paul, MN). The composite was placed and light cured for 20 seconds.
- Group 2 (TE with caries detecting dye): Caries detection dye (Reveal caries indicator, Prevest Denpro, India) was applied for 10 seconds and rinsed for 10 seconds. The cavities were then restored with composite as mentioned in Group 1.
- Group 3 {Self-Etch Adhesive system (SEA) without caries detecting dye}: SEA (Single bond universal, 3M Deutschland GmbH, Neuss, Germany) was scrubbed for 20 seconds on to the prepared cavity, air thinned and cured for 20 seconds. Following this the cervical cavities were restored with composite as mentioned above.
- Group 4 (SEA with caries detecting dye): The teeth assigned to this group were initially treated with the caries disclosing solution as mentioned in Group 2 and then restored with composite as mentioned in Group 3.

Preparation of the samples for microleakage: After restorative procedures were done, the samples were polished using (Sof-Lex (3M ESPE, St. Paul, MN, USA) and was kept in saline when not in use. The apices of the samples were sealed and two coats of nail varnish were used to cover the specimens, excluding the restoration surface and the surrounding 2 mm area. The specimens were inverted and placed in a solution of 2% Rhodamine-B (Lobachemie, India) dye for 24 hours. After removal of the specimens from the dye solution, longitudinal sections of the teeth were done bucco-lingually through the centre of the restorations using a low-speed diamond disc (Brasseler USA, Savannah, GA). The sections were then evaluated with a fluorescent microscope (Olympus CX41, Olympus Microscopy Europa) at 10x magnification to determine the extent of dye penetration at the cavity margins by two evaluators who were blinded to the study.

Dye scoring criteria: The level of dye penetration was evaluated according to the scoring system mentioned in [Table/Fig-1] [7]. In *Score 0* there is no dye penetration; in *Score 1*, the dye penetration is present less than half of the cavity depth along the external wall; in *Score 2* the dye is present along the external wall involving more than half of the cavity without extending on to the axial wall and in *Score 3*, the dye penetration is present along the full cavity depth and extending onto the axial wall.



[Table/Fig-1]: Scoring criteria: (a) No dye penetration (Score 0); (b) Dye penetration along the external wall which is less than half the cavity depth (Score 1); (c) Dye penetration along the external wall which is more than half the cavity depth but not extending onto the axial wall (Score 2); (d) Dye penetration along the full external wall extending onto the axial wall (Score 3).

STATISTICAL ANALYSIS

Microleakage scores based on the adhesive strategy used and the bonded substrate were recorded and the data obtained was subjected to statistical analysis using Chi-square test. The statistical analysis was carried out using SPSS Version 16.0 (SPSS Inc., Chicago IL). For the analysis, the level of significance was set at $p<0.05$.

RESULTS

The inter-examiner agreement of scores of enamel microleakage assessment was 23/34 which was 67.64% with a kappa value of 0.552, indicating moderate agreement (p=<0.001). For the microleakage score of the cementum wall, the agreement of scores was 17/27, which was 62.9% with a kappa value of 0.552, indicating moderate agreement. The microleakage scores for enamel and cementum have been given in [Table/Fig-2]. No significant difference was detected between the groups ($p>0.05$). Thus the null hypothesis was accepted. However, Group 3 (self-etch without dye) showed the least percentage of microleakage with none of the restorations showing grade 3 leakage score. Though not statistically significant, a slightly higher incidence of increased leakage was seen in the total etch group, especially in the cementum margin.

DISCUSSION

Microleakage is a big concern in the dental world as it is one of the major causes of apical periodontitis and an important cause of root canal treatment failure [8]. Various methodologies have been

	Microleakage score	Total (n)	Group								Chi-square	p-value
			Group 1		Group 2		Group 3		Group 4			
			Count	Percentage (%)	Count	Percentage (%)	Count	Percentage (%)	Count	Percentage (%)		
Enamel	Grade 0	6	2	20.00%	1	11.10%	2	28.60%	1	12.50%	9.19	0.42
	Grade 1	7	2	20.00%	0	0.00%	3	42.90%	2	25.00%		
	Grade 2	8	2	20.00%	2	22.20%	2	28.60%	2	25.00%		
	Grade 3	13	4	40.00%	6	66.70%	0	0.00%	3	37.50%		
Cementum	Grade 0	5	0	0.00%	2	28.60%	2	33.30%	1	20.00%	16.603	0.055
	Grade 1	1	0	0.00%	0	0.00%	0	0.00%	1	20.00%		
	Grade 2	8	3	33.30%	0	0.00%	4	66.70%	1	20.00%		
	Grade 3	13	6	66.70%	5	71.40%	0	0.00%	2	40.00%		

[Table/Fig-2]: Microleakage scores for the study groups in enamel and cementum.

introduced to assess degree of microleakage. Dye penetration method is found to be dependable in microleakage assessment [9]. It is highly feasible and easily reproducible [10]. Guidelines were followed by emphasising the need to standardise tooth quality, type of cavity preparation, and method to evaluate microleakage at the margin to maintain transparency. Rhodamine B dye, which is a fluorescent dye, was used to assess degree of microleakage due to its fluorescent nature. Rhodamine B dye is also more sensitive than a conventional dye. On the other hand, Rhodamine B dye was used instead of methylene blue as it has smaller and more surface active molecules [11].

In the present study, microleakage was observed to be slightly more in cemental margin, compared to the enamel margin, though not statistically significant. It was in accordance with the study by Owens BM et al., [12]. This could be due to the presence of coarse collages fibres in cementum resulting in less and inhomogeneous penetration of resin monomers into the etched zone [6,13].

The present study showed increased microleakage in groups using the total etch system compared to the self-etch system. This result is in accordance with the study done by Gupta A et al., [14]. In total etch adhesives; the smear layer is completely dissolved. However, in self-etch adhesives, the acidic active components are responsible for dissolving the smear layer. The acidity is buffered by the mineral content of dentin, thus chemical interaction between some functional monomers and the remaining hydroxyapatite crystals along the collagen fibrils improve bond durability [15]. Self-etch adhesives are easy to use and theoretically able to etch and infiltrate at the same time, decreasing the inconsistency between demineralisation and infiltration [16].

In the present study, the use of caries detecting dye showed an increase in microleakage percentages compared to the absence of the dye. Although no statistical difference was shown through the results, the microleakage percentages in samples which used caries detecting dyes, were shown to be higher than the ones without dye. The higher incidence of dye leakage when compared to the study by Piva E et al., could be due to the difference in the composition of the caries disclosing solution used [7]. According to Demarco FF et al., the dye can be trapped in the dentin even after washing or acid etching [17]. This dye particle can affect the bonding of composite to the tooth structure. Thus, use of caries detecting dye should be done with caution, especially with adhesive restorative materials.

LIMITATION

Being an in-vitro study, this study had its own limitations. Intraoral variables like temperature changes as well as effects of masticatory stresses and fatigue load were not taken into consideration. Further studies need to be conducted to evaluate the adhesion of composite resin, especially on caries affected dentin, after the use of various caries detecting dye to simulate the clinical scenario better.

CONCLUSION

Within the limitations of this study, it was possible to conclude higher leakage, though not statistically significant was seen in the total etch group than the self-etch adhesive group. In addition, the cavities exposed to caries detecting agent showed more leakage than those without its usage.

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