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ORIGINAL RESEARCH

Evaluation of Microleakage in Class V Restorations with Three different Adhesive Systems

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ABSTRACT

Aim: This study was conducted to evaluate the microleakage of class V cavities restored with composite resin and different adhesive systems.

Materials and methods: In this experimental epidemiological investigation, a total of 75 freshly extracted human teeth were collected. The teeth were randomly divided into three groups (n = 25). Three different intermediate adhesive materials (Clearfil SE Bond, Single Bond, and Xeno III) were used for each group.

Results: On testing without the application of occlusal load, the maximum microleakage was seen for group III (Xeno III) followed by group I (Clearfil SE) and then group II (Single Bond). On application of occlusal load, the maximum microleakage was seen for group III (Xeno III) followed by group II (Single Bond) and then group I (Clearfil SE Bond). The data were analyzed statistically using Kruskal–Wallis and Mann–Whitney U test.

Conclusion: Group III showed the maximum amount of microleakage both with and without occlusal load.

Clinical significance: All adhesives under investigation exhibited a certain amount of microleakage in enamel and dentin.

Keywords: Adhesive systems, Class V cavities, Composite resin, Microleakage.

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INTRODUCTION

Access to fluoride in conjunction with effective preventive programs and enhanced dental care in the past few decades has facilitated better maintenance of natural teeth.[1] As a result of aging, gingival recession, and dentin exposure, the cervical defects and root caries have become more prevalent.[2] The stresses induced in cervical region due to heavy occlusal forces generated during normal functional and parafunctional movements may lead to microleakage or deterioration of margins of the class V restorations. Despite the use of composite resins as a material of choice in such cavities, relevant drawbacks, such as inherent polymerization shrinkage may cause microleakage.[3] Furthermore, an adhesive restoration might not bond sufficiently to the etched dentin to prevent gap formation at the margins enabling the bacteria to survive, proliferate, and penetrate through such gaps. In addition, smear layer itself can serve as a pathway for microleakage.[4] Dentin adhesives remove the smear layer, seal the resin dentin interface, and prevent the exposure of pulp dentin complex to bacteria and their toxins. Although some *in vitro* studies have shown such sealing capacity for total-etch dentin adhesive system, others associate the occurrence of severe leakage with the same.[5] This study was conducted to evaluate the microleakage of class V cavities restored with composite resin and different adhesive systems.

MATERIALS AND METHODS

This study was conducted at the Department of Conservative Dentistry and Endodontics, Chhatrapati Shahuji Maharaj Medical University, Lucknow, India. For this *in vitro* study, 75 freshly extracted human teeth were collected.

Distribution of Samples in Groups

The teeth were randomly divided into three groups (n = 25). Three different intermediate adhesive materials

(Clearfil SE Bond [Kuraray, Osaka, Japan], Single Bond [3M ESPE], and Xeno III [Dentsply De Trey, Konstanz, Germany]) were used for each group. Each group was then divided into subgroups labeled as subgroups I–III. Five samples in each subgroup were tested without occlusal loading to serve as control, whereas the remaining 20 were subjected to an occlusal load.

Methodology

Standard box-shaped cavities having dimensions of 3 × 3 × 2 mm were prepared with carbide bur on the middle third of the buccal surfaces, with the floor of the cavity in dentin. After rinsing with water and gently air drying for 30 seconds, intermediate adhesive material was applied to the samples.

Clearfil SE Bond, a two-step bonding system was used for group I samples. Clearfil SE Bond Primer was applied for 20 seconds, dried with mild airflow, followed by application of Clearfil SE Bond and light cured for 20 seconds. Similarly, Single Bond was used as an intermediate adhesive for group II samples (total-etching). Xeno (III), a universal self-etching one bottle bonding agent, was used for group III samples (self-etch adhesives).

The samples were restored in two increments with (Filtek Z350XT) composite and cured for 20 seconds per increment. Finishing of the restoration was with scalpel and polishing was done with aluminum oxide discs (3M ESPE). All the samples were thermocycled between 5°C (20 seconds) and 55°C (10 seconds) in a water bath and transverse time of 10 seconds (200 times). Two layers of nail varnish were applied on the entire tooth surfaces except for the restoration and approximately 2 mm around them.

The samples were embedded in plastic blocks (7.112 × 3.95 cm approximately) up to 2 mm apical to cervical wall of the restoration. Five samples of each subgroup (I–III) served as control as no occlusal load was applied onto them, whereas the remaining 20 samples were subjected to (Instron, Canton, MS, USA) machine for occlusal loading. The samples were subjected to axial load of 250 N at a speed of 5 mm/minute.

Afterward, samples were immersed in 0.5% methylene blue dye sol for 24 hours. Excess dye and nail varnish were removed. Teeth were then split buccolingually into two halves longitudinally using double-sided abrasive diamond disc. The split halves were then subjected to microleakage evaluation under stereomicroscope under 10× magnification (model number: XTL 3400 E). The degree of microleakage was evaluated using a standard ranking as no dye penetration (0), dye penetration along with one wall (1), dye penetration along with both walls (2), dye penetration along with all walls (3), and dye penetration in the material along with all three walls of the cavity (4).

Data Analysis

Data were analyzed using Statistical Package for the Social Sciences version 15 (SPSS, Chicago, Illinois, USA). The data were analyzed statistically using Kruskal–Wallis and Mann–Whitney U test. Dentin enamel margins were compared with each other on signed rank test.

RESULTS

A total of 25 specimens for each material were tested under two different conditions. Each group was then divided into subgroups labeled as group I – Clearfil SE bond, group II – Single Bond, and group III – Xeno III.

On testing without the application of occlusal load, the maximum microleakage was seen for group III (Xeno III) (3.00 ± 0.707) followed by group I (Clearfil SE) (2.20 ± 0.837) and then group II (Single Bond) (1.40 ± 0.894). When analysis of variance was performed using Kruskal–Wallis test, the mean ranks of the three groups stood apart with group II having minimum, while group III had maximum mean rank (Table 1). Intergroup comparison of microleakage showed no statistically significant difference between groups I and II and between groups I and III.

On application of occlusal load, the maximum mean value of microleakage was seen for group III (Xeno III) followed by group II (Single Bond) and then group I (Clearfil SE Bond). When analysis of variance was performed using Kruskal–Wallis test, group III had maximum mean rank whereas groups I and II stood too close (Table 2). After the application of occlusal load, no statistically significant difference was seen between groups I and II and between groups I and III. However, the difference between groups II and III was found to be significant statistically.

Table 1: Microleakage without the application of occlusal load

Groups	Number of specimens	Microleakage score Mean ± SD	Mean rank
I – Clearfil SE Bond	5	2.20 ± 0.837	7.90
II – Single Bond	5	1.40 ± 0.894	4.60
III – Xeno III	5	3.00 ± 0.707	11.50

SD: Standard deviation

Table 2: Microleakage after the application of occlusal load

Groups	Number of specimens	Microleakage score Mean ± SD	Mean rank
I – Clearfil SE Bond	20	2.10 ± 1.165	25.40
II – Single Bond	20	2.15 ± 1.348	24.68
III – Xeno III	20	3.25 ± 0.967	41.43

SD: Standard deviation

DISCUSSION

Due to increased demand for esthetic restorations and availability of a variety of products in the market, it is necessary to evaluate the quality and reliability of the new adhesive systems and composite resin in reducing the microleakage, as the inability to maintain a seal between restoration tooth interface have been found to be a primary reason for failure of class V composite resin restorations.[6-9] The primary objective of the study was to evaluate microleakage of class V cavities restored with composite resin and with different adhesive systems after occlusal loading. After the preparation of standard cavities on the middle third of the buccal surfaces, intermediate adhesive material was applied to all sample groups. Adhesive systems bond the composite resin to the tooth surface and are a part of a hybrid layer formed during the process of adhesion, either by total-etch or self-etch technique.

In this study, the adhesive systems used were:

Group I: Two-step self-etch (Clearfil SE Bond, Kuraray Medical), a light-curing bonding system consisting of self-etch primer and a bonding agent, was used.[10]

Group II: Two-step total-etch (Single Bond, 3M ESPE) was used. It consists of bisphenol A glycidyl methacrylate, 2-hydroxylethyl methacrylate, water ethanol, photo initiator, and polyalkenoic acid copolymer.

Group III: One-step self-etch (Xeno III Dentsply/Clauk, Mildford) was used. This system offers integrated precise etching.

Of all the samples, 60 samples were subjected to an occlusal load of 250 N because the estimated true total forces during bilateral clenching range from 265 to 2585 N. The dye penetration method allows easy quantitative measurement technique. Methylene dye was used as its molecular size is similar to bacterial by-products, such as butyric acid, which can leak out of prepared surfaces on the sample teeth and irritate tissue. After dye immersion, teeth were sectioned longitudinally. The sectioned halves of the samples were viewed under a stereomicroscope using a 10× magnification and assessment for dye penetration was done at occlusal and cervical margins.

Despite the continuous evaluation of adhesive systems, no currently available technique has been able to produce predictable results when the preparation margins are located in the dentin.[11] Contraction stresses generated during placement of a composite restoration contribute significantly to early marginal leakage, especially in dentin.[12] The lower bond strength obtained in dentin is not strong enough to counteract the stress developed during polymerization shrinkage which impairs sealing capacity.[13] In this study, three different adhesive systems were used because they create a hybrid layer with different mechanisms via the treatment of smear layer produced during cavity preparation.[14] When no occlusal load was applied, there were no statistically significant differences between etch and rinse system and self-etching systems but when restoration was loaded occlusally, there were statistically significant differences in total-etch and one-step self-etch adhesives. This finding is in agreement with Wahab et al.[15] However, Brackett et al[16] in their study also showed no significant difference in the microleakage difference between self-etch adhesives and total-etch adhesives.

Furthermore, of all the materials tested, there was no significant difference between mechanical loadings with 250 N. The reason for this could be axial loading direction. It has been suggested that the occlusal load causes the tooth to flex, particularly during lateral excursions. As the tooth flexes, tensile and shear forces are generated in the cervical region of the tooth.[17]

From the result of this study, it is evident that microleakage was highest in the experimental group (with occlusal loading), i.e., Xeno III (one-step self-etch) of the three materials used. In this study, the highest microleakage was observed in Xeno III (one-step self-etch) followed by Clearfil SE (two-step self-etch) and Single Bond (two-step total-etch). In contrast to the present data, it was observed that Xeno III self-etch adhesive had a smaller amount leakage than Prime and Bond NT total-etch adhesive.[18]

CONCLUSION

All adhesives under investigation exhibited a certain amount of microleakage in enamel and dentin. At both enamel and dentin/cementum margin, two-step self-etch adhesive performed better than one-step self-etch adhesive. At both enamel and dentin/cementum margin, there is no significant difference in microleakage between two-step self-etch and one-step self-etch adhesive.

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