Comparison of Microleakage of Two Materials Used as Fissure Sealants with Different Methods: An *In vitro* Study

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ABSTRACT

Background: Marginal seal has a principal role in durability and clinical success of fissure sealants. The aim of this study was to compare the microleakage of two materials used as pit and fissure sealant with different methods of application.

Methods: The 55 extracted premolars were assigned randomly to one of the following five groups: Group 1: Acid-etching (ultra-etch) + fissure sealant (conventional method), Group 2: Acid etching + bonding agent (single bond) + fissure sealant, Group 3: Self-etching primer + bonding agent (SE bond) + fissure sealant, Group 4: Acid-etching + bonding agent + flowable composite (Filtek flow), Grope 5: Self-etching primer + bonding agent + flowable composite. Following sealant placement, the teeth were thermocycled (3000 cycles; 5-55°C) and then immersed in 50% silver nitrate solution for 24 h and then immersed in photo developing solution for 4 h under fluorescent light. The teeth were then sectioned in a bucco-lingual direction. Microleakage was scored using a stereomicroscope and a 4-criteria ranking/ordinal scale. Data were analyzed statistically using the Kruskal-Wallis and Mann-Whitney tests.

Results: The result of tests showed that there were statistical differences between some groups. Groups 2 and 4 had the lowest and Groups 3 and 5 had the highest microleakage scores and a statistically significant difference could be displayed between them ($P < 0.05$). Mean microleakage in Group 4 was also significantly lower than in Group 1 ($P < 0.05$).

Conclusions: Using acid and a bonding agent prior to sealant placement seems to be the best technique for sealing pits and fissures.

Keywords: Bonding agent, fissure sealant, flowable composite, microleakage

Original Article

INTRODUCTION

Modern preventive dentistry advancements, the widespread public acceptance of fluoridation and the greater emphasis on dental hygiene have considerably affected the nature of dental

care profession. Nevertheless, caries restoration is still one major activity of Pediatric Dentists.[1] Although fluoride application has led to significant caries decrease in smooth surfaces of enamel and cementum, it has not been as promising in protecting occlusal pits and fissures and 50% of carious lesions still occurs on the occlusal surfaces.[2] The fact that occlusal surface makes only 12% of total dental surfaces suggests that pits and fissures are 8 times more caries-susceptible than smooth surfaces.[2,3] Therefore, sealant placement is nowadays considered to be an effective means of preventing caries in occlusal surfaces. Since 1975 when the first methyl methacrylate sealant was used,[1,4] quite a number of changes have occurred. Yet the main material used in sealants is still BIS-GMA monomers.[1] The most acute problem with sealants is the leakage problem; none of the restorative materials available are intrinsically resistant to microleakage.[1] However, the application of acid etching results in better micromechanical binding, which in turn causes less microleakage.[1,5] Since marginal leakage interferes with the formation of a protective barrier between the teeth and the oral environment thus, allowing the permeation of *mutans streptococci*, fermentable carbohydrates and destructive agents,[2,6] this study tried to make an *in vitro* comparison of the microleakage of two agents used in fissure sealants and introduce the superior technique and agent.

METHODS

Study design and samples

This experimental, non-directional, *in vitro* study through using simple random sampling technique was conducted in Torabinezhad Research Center in Isfahan.

Procedures

Fifty-five premolar teeth extracted for orthodontic reasons and assessed to bear no cavity, anatomic abnormality, distinct crack and surface pigment were selected. The teeth were cleaned with the prophylaxis brush and the periodontal fibers were also removed. The teeth were then preserved in thymol solution 0.2% for 24 h and later in distilled water at room temperature. Thus, 2 months before the experiment, 55 teeth were prepared. The teeth were divided into five groups. Before sealant therapy, the teeth were completely cleaned with the prophylaxis brush and sound. Fifty five extracted premolars were assigned randomly to one of the following five groups: Group 1: Acid-etching Ultra Etch Ultradent Products Inc., South Jordan, Utah, USA]) + fissure sealant Helioseal Clear Ivoclar Vivadent Ets, Schaan, Liechtenstein conventional method)], Group 2: Acid etching + bonding agent single bond + fissure sealant, Group 3: Self-etching primer + bonding agent SE bond Kurary Medical Inc. Okayam, Japan + fissure sealant, Group 4: Acid-etching + bonding agent + flowable composite [Filtek Flow (3M Dental Products Inc., St. Paul, Minn, USA)], Grope 5: Self-etching primer + bonding agent + flowable composite. Following sealant placement, the teeth were thermocycled (3000 cycles; 5-55°C) and then immersed in 50% of silver nitrate solution for 24 h and then immersed in photo developing solution for 4 h under fluorescent light. The teeth were then sectioned longitudinal. Microleakage was scored using a stereomicroscope and a 4-criteria ranking/ordinal score. Score 0: Without microleakage, Score 1: Color penetration to 1/3 occlusal thick of sealant, Score 2: Color penetration to 2/3 occlusal thick of sealant, Score 3: Color penetration to the total depth.

Statistical analysis

Data were analyzed statistically using the Kruskal-Wallis and Mann-Whitney test. The minimum P value for being meaningful was assumed 0.05.

RESULTS

Table 1 illustrates the frequency distribution of microleakage rate in the study groups and Figure 1 shows the general results of the study.

Since the recorded values for microleakage were of ordinal nature, the Kruskal-Wallis test was firstly applied [Table 2]. The result showed there were significant differences between the study groups ($P < 0.05$). Then the Mann-Whitney test showed ($P < 0.05$) that Groups 2 and 4, namely where acid etching and bonding agent had been used, had the highest frequency of score: 0 (no micro leakage) and the lowest frequency of score: 3 (complete microleakage), indicating in these groups complete microleakage had not occurred at all.

Table 1: Frequency distribution of microleakage rate of different groups

Leakage score count (%)	Leakage group cross tabulation					Total
	1 (Conventional)	2 (Acid+ bonding+ selant)	3 (SE bond+ sealant)	4 (Acid+bonding+ flowable composite)	5 (SE bond+ flowable composite)	
(Score 0) count (within group)	4 (36.4)	9 (81.8)	4 (36.4)	9 (81.8)	3 (27.3)	29 (52.7)
(Score 1) count (within group)	4 (36.4)	1 (9.1)	1 (9.1)	2 (18.25)	4 (36.4)	12 (21.8)
(Score 2) count (within group)	1 (9.1)	1 (1.9)	3 (27.3)	0 (0)	1 (9.1)	6 (10.9)
(Score 3) count (within group)	2 (18.2)	0 (0)	3 (27.3)	0 (0)	3 (27.3)	8 (14.5)
Total	11 (100.0)	11 (100.0)	11 (100.0)	11 (100.0)	11 (100.05)	55 (100.0)

Table 2: Kruskal-Wallis test for five study groups

Ranks		Mean rank
Groups	*N*	
Leakage		
1 (Conventional)	11	31.77
2 (Acid+bonding+selant)	11	19.55
3 (Self-etching primer+bonding+sealant)	11	34.86
4 (Acid+bonding+flowable composite)	11	18.73
5 (Self-etching primer+bonding+ flowable composite)	11	35.09

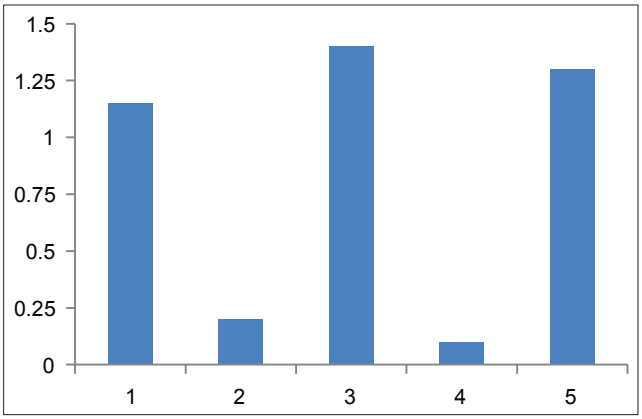

Figure 1: Comparison of Microleakage Rate in the Study Groups (X axes: Number of group-y axes: Mean Microleakage)

In Groups 3 and 5, where self-etching primer and bonding agent (SE bond) had been used, the highest frequency of Score 3 (complete microleakage) was observed. In Group 1, there were two specimens with Score 3 and 4 specimens with Score 0 (no microleakage). Thus, the Mann-Whitney test showed the lowest microleakage had happened in Groups 2 and 4 and the highest in Groups 3 and 5. Findings related to Groups 2 and 4 on one hand and Groups 3 and 5, on the other hand were very much similar as it was explained, the similar techniques were used in these groups. Although there was no significant difference between the findings in Groups 2 and the difference was close to significant ($P > 0.05$). Mean microleakage in Group 4 was also significantly lower than in Group 1 ($P < 0.05$).

DISCUSSION

In this study, the microleakages of two material agents used as fissure sealants were compared. Resinous sealants prevent caries development through forming a mechanical barrier between the grooves of teeth and the oral environment interrupting metabolic exchange. Thus, unlike glass ionomers which depend on fluoride uptake for success, the efficacy of resinous sealants is dependent on retention and integrity.[7] Hence, in this study, microleakage, as one of the most important indicators of success or failure of sealant therapy has been investigated. Pumice prophylaxis and enameloplasty were avoided. Though a number of studies argue that pumice prophylaxis plays an important role in fissure sealant retention, there is still a controversy over the matter. Although many Dentists apply pumice prophylaxis as the first step in fissure sealants, there has been no significant difference in retention with or without pumice prophylaxis.[8] Some researchers propose that pumice may remain in the depths of grooves and interfere with resin infiltration into those parts.[9] As for enameloplasty, similarly there is no unanimity. Some of the studies[10] have found it necessary for reducing sealant microleakage, while others have regarded it unnecessary. However, Celiberti and Lussi[11] argue that although enameloplasty provides better access to the depths of the grooves when etching, which helps resin infiltration, the probability of sealant microleakage increases when

a larger region is covered by the sealant. This is due to greater movements of the sealant margins. For this reason and also because this study, like all other similar studies aimed to reach a simpler procedure for sealant therapy, enameloplasty was not applied, to make it possible to observe only the effect of the materials and the techniques used. In our study, no anatomical distinction was made between groove depths. The reason was that some studies have shown that there is no significant difference in microleakage in anatomically different grooves.[12] The device used for curing was a blue phase LED. Since the device has a built-in radiometer, it makes it possible to make sure all specimens receive the same amount of output energy.

Furthermore, we applied flowable composite only after the application of the bonding material/agent because findings of a study by Kwon and Park in 2006[13] showed that the application of flowable composite on etched surfaces without using bonding agents did not bear favorable results. The results of our study showed that microleakage occurred in all the study groups with varying extents, which is in concordance with other studies on microleakage of fissure sealants.[8,14-17] The Mann-Whitney test showed there was a significant difference between a numbers of the groups in microleakage. The results of the test revealed the least microleakage existed in groups where acid etching and bonding agent had been used. It also showed microleakage was maximum in groups where self-etching primer and bonding agent had been applied. As it is seen, these results are in agreement with the finding of studies which suggest the use of bonding agents following etching positively affects the sealant therapy.[18-20] Considering the results, it is seen that in Groups 2 and 4 in which acid-etching and bonding agents were applied, a high percentage of the specimens (81.8%) showed no microleakage and complete microleakage did not occur in any of the specimens. As it was noted earlier, neither enameloplasty nor pumice prophylaxis was applied in this study; therefore, it could be concluded that acid etching by using bonding agents positively affect sealant therapy. Further studies might reveal that enameloplasty and pumice prophylaxis are not required for sealant therapy.[8] The application of self-etching primers for preparation of occulusal surfaces (in Groups 3 and 5) was not efficient, which is similar to the findings of other similar studies.[11,21] Ram *et al*.[21] recommends using conditioners without cleansing only when cleansing is impossible. Furthermore, the findings of a study conducted by Hannig *et al*. in 2004,[11] in accordance with our findings, suggest the application of self-etching primers does not promote sealant therapy. Findings of a very similar study by Pardi *et al*. in 2006 shows that microleakage of the flowable composite (Filtek) is similar/equal to that of Delton sealant.[16] We used 50% of silver nitrate solution for 24 h. As the particles are thinner than in other agents, silver nitrate has the highest infiltration rate among other agents used for dye infiltration technique applied in microleakage studies.[16] Dye infiltration period was also longer (24 h) in our study. These reasons could possibly explain the difference between the findings of our study. Comparison of microleakage rate in Group 1 (conventional approach) and Group 2 (acid etching + bonding agent + sealant) showed a near-to-significant difference. This may change to a significant difference if the number of specimens is increased. Comparison of microleakage rate in Group 1 (conventional approach) and Group 4 (acid-etching + bonding agent + flowable composite) showed a significant difference. Mean microleakage in Group 4 was significantly lower than in Group 1. Considering the high rate of microleakage in Groups 3 and 5, the application of self-etching primers, even when a simple and short procedure is desired, is not recommended. When it is possible to add a further step, that is, the application of a bonding agent to sealant therapy, our findings suggest that it will decrease the microleakage rate, if the bonding agent is used before sealant placement. Otherwise, when money matters, the conventional sealant therapy approach is recommended.[22] From the results and findings of this study, it could be proposed that under a similar technique the application of both the flowable composite and fissure sealant results in the same microleakage rate. Therefore, the flow able composite could substitute fissure sealants in sealant therapy only if further studies can show it outperforms fissure sealants in term of retention and other properties such as wear resistance.

CONCLUSIONS

Based on the findings of this study, it can be concluded that the best sealant therapy technique

is acid-etching bonding agent and then application of sealant (conventional sealant or flow able composite). The application of acid-etching and bonding agent together with the flowable composite is recommend.

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