Comparison of six different methods of cleaning and preparing occlusal fissure surface before placement of pit and fissure sealant: An *in vitro* study

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Abstract

Aim & Objectives: The purpose of this *in vitro* study was to evaluate and compare the microleakage of pit and fissure sealants after using six different preparation techniques: (a) brush, (b) pumice slurry application, (c) bur, (d) air polishing, (e) air abrasion, and (f) longer etching time. **Material & Method**: The study was conducted on 60 caries-free first premolars extracted for orthodontic purpose. These teeth were randomly assigned to six groups of 10 teeth each. Teeth were prepared using one of six occlusal surface treatments prior to placement of Clinpro” 3M ESPE light-cured sealant. The teeth were thermocycled for 500 cycles and stored in 0.9% normal saline. Teeth were sealed apically and coated with nail varnish 1 mm from the margin and stained in 1% methylene blue for 24 hours. Each tooth was divided buccolingually parallel to the long axis of the tooth, yielding two sections per tooth for analysis. The surfaces were scored from 0 to 2 for the extent of microleakage. **Statistical Analysis**: Results obtained for microleakage were analyzed by using t-tests at sectional level and chi-square test and analysis of variance (ANOVA) at the group level. **Results**: The results of round bur group were significantly superior when compared to all other groups. The application of air polishing and air abrasion showed better results than pumice slurry, bristle brush, and longer etching time. Round bur group was the most successful cleaning and preparing technique. Air polishing and air abrasion produced significantly less microleakage than traditional pumice slurry, bristle brush, and longer etching time.

Key words

Microleakage, pit and fissure sealants, surface preparation techniques

Introduction

Despite diligent oral hygiene procedures, optimal fluoride environment, and a realistic approach to dietary modifications, occlusal caries is inescapable for most children and adolescents as a result of the anatomy of pit and fissure surfaces, which favors stagnation of bacteria and substrates.[1] Sealing pits and fissures with a resin material in caries-susceptible teeth forms a micromechanically retained, physically protective layer that acts to prevent the demineralization of enamel by blocking the interaction of cariogenic bacteria and their nutrient substrates, thus eliminating the harmful acidic byproducts, and this is regarded as a definitive mode of treatment in prevention of dental caries.[2]

The ability of sealants to resist the introduction of caries is determined to a great extent by the integrity of enamel sealant interface such that it prevents microleakage at its periphery; otherwise, the carious process might be supported and continues under the sealant.

This in turn depends upon an optimal clinical technique by the dentist; therefore, evaluation should not be limited only to the physical, chemical, or biological acceptance of the material used as a fissure sealant, but emphasis should be placed also on the technique for cleaning and preparing the tooth surface to accept the sealant placement.[1]

Residual material in the fissure, air entrapment, and fissure geometry itself contribute to limiting of the sealant penetration, making it necessary to have a good clinical technique. Their application involves tooth prophylaxis followed by conditioning with acidic agent. This protocol designed to remove deposits from the tooth and to enlarge existing microspores in the enamel to accommodate resin sealant may or may not completely and consistently remove deposits from pits and fissures.[1]

Preparation of tooth surface prior to etching, which may vary from the use of dry pointed bristle brush, use of rubber cup and pumice slurry, invasive methods such as opening up of fissures using dental bur to more recent advances such as abrading the surface enamel with a slurry of sodium bicarbonate or aluminum oxide particles under pressure or even prolonging the etching time, are all based on materials and instruments currently used in clinical practice.

Preventive dentistry can play a significant role in alleviating the oral health status of the pediatric population. Pit and fissure sealants which are an integral part of this form of dentistry can contribute considerably in this endeavor. Hence, there is a need to investigate and compare the effectiveness of different methods of cleaning and preparing occlusal fissures to receive pit and fissure sealants so as to make them more acceptable and reliable.

The purpose of this study was to investigate and compare the effectiveness of these different methods for cleaning and preparing of occlusal fissure before sealant placement to control microleakage.

Materials and Methods

Sixty caries-free first premolars extracted for orthodontic purposes were selected for the study. The absence of caries was determined according to the clinical parameters using a sharp explorer and visual inspection. The specimens were cleaned under tap water and any periodontal tissues attached to the roots of the teeth were removed with periodontal scalers prior to their preservation in thymol. They were randomly assigned to six groups of 10 teeth each for receiving fissure sealant (Clinpro™ 3M ESPE, USA). Each group contained teeth with almost similar occlusal table size. The groups were as follows:

Group I: Brushing only. The fissures were cleaned with a dry pointed bristle brush using a low-speed hand piece for approximately 10 seconds.

Group II: Application of pumice slurry. The fissures were cleaned with a slurry of fine flour of pumice in water (5 g/4 ml water) using a rubber cup in a low-speed hand piece for approximately 10 seconds.

Group III: Opening of fissures with round carbide bur. The fissures were opened with a new round carbide bur (#1/4) in a high-speed hand piece to approximately the width and depth of the bur diameter (0.5 mm).

Group IV: Air polishing. The fissures were prepared with one or two passes of the hand piece of the Prophy polishing pencil (Sunny, Brazil) with the nozzle kept close to the tooth surface directing the sodium bicarbonate and water slurry over the fissure surface.

Group V: Air abrasion. The fissures were prepared with one or two passes of the Air Sonic Mini Sand blaster System (Microetcher ERC, Danville Engineering, USA) using 50 mm alumina particles at 80 psi pressure flow.

Group VI: Longer etching time. The fissures were cleaned with a dry pointed bristle brush using a low-speed hand piece and a 60-second etching procedure was used prior to placement of sealant as compared to 30-second etching for other groups.

Subsequent to fissure preparation, the fissures were etched using 35% phosphoric acid gel Scothbond (3M ESPE, USA) for 30 seconds except for group VI where the surface was etched for 60 seconds.

The samples were then rinsed for 10 seconds using air water spray of the three-way syringe and dried using oil-free compressed air with a hand pump air pressure syringe. After ensuring a frosted appearance of the enamel at the fissure entrance, Clinpro 3M ESPE pit and fissure sealant was applied on the surface according to manufacturer's instructions. To avoid voids and air entrapment, a 0.5-mm-tip diameter periodontal probe was used to push the sealant into the fissure and any obvious bubbles were removed with the tip of the probe. The sealant was then cured for 20 seconds using visible light (Monitex BlueLex 105) curing unit. The specimens were incubated for 24 hours in distilled water at room temperature. All the samples were then thermocycled 500 times in water baths of 5°C and 55°C with a dwell time of 30 seconds in each bath.

Two coats of acid-resistant varnish were applied to all tooth surfaces except for 1-mm diameter surrounding the sealant. The apices of the roots were sealed with sticky wax.

The teeth were immersed in 1% aqueous solution of methylene blue dye for 24 hours following which they were washed to remove the excess dye. The varnish and sticky wax were scraped off and specimens were embedded in acrylic blocks up to cemento-enamel junction. Approximately 1.5-mm-thick sections were made longitudinally with a water-cooled diamond disk in bucco-lingual direction. The sections were then kept dry and observed for microleakage on both sides of each section; thus, a total of 20 sides were scored in each group (n=20) using a stereomicroscope with magnification of ×10. The degree of microleakage was scored by a single observer using the criteria by Cooley *et al.*[3] [Chart 1].

The sections were photographed to show a score of 0, 1, or 2 microleakage.

Cooley *et al.* criteria for grading microleakage

Score	Interpretation
0	No marginal penetration by dye
1	Marginal penetration along the enamel sealant interface
2	Dye penetration to depth of sealant

Results

The present *in vitro* study was conducted to evaluate the microleakage of various methods of preparation of occlusal surface prior to pit and fissure sealant placement (Clinpro 3M ESPE). The data were statistically analyzed. To find whether microleakage in the six groups was homogenous, analysis of variance (ANOVA) was conducted. To find between which two groups there was significant difference in leakage, unpaired "t" test was conducted. Chi-square test with Yates correction was used for different pairs of groups to test the independence of the scores and the groups.

Table 1 shows the frequency distribution of degree of microleakage for Groups I–VI. The highest number (20/20) of sections with "0" microleakage score was within the bur group and the lowest number (9/20) of sections with "0" score was with conventional pumice prophylaxis [Figure 1].

The maximum number[3] of sections with the highest microleakage score of "2" was within two groups – brushing only and longer etching time.

Total percentage of sections with microleakage score of "1" was 23.3% out of all the sections examined. Total percentage of sections with microleakage score of "2" was 5.8% out of all the sections observed. 70.80% of the total sections showed "0" microleakage.

Table 2 is the table of ANOVA. Tabled value of "F" for 5, 114 degrees of freedom was 3.17 at P<0.01. Since the calculated value of F (5.3087) was larger than the tabled value, it was observed that no homogeneity existed among the six groups.

Table 3 shows the method of preparation of occlusal surface by brushing only (Group I), pumice slurry (Group II), and with longer etching time (Group VI) to be comparable as the degree of microleakage between them was not significant (t=0.0000; P<0.05).

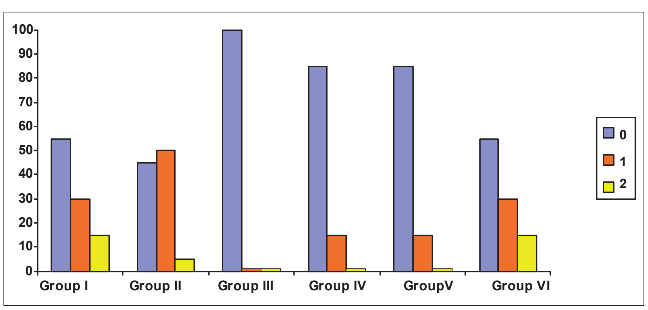

Chart 1: A comparison of dye penetration (microleakage) by different methods of preparation (Groups I,VI)

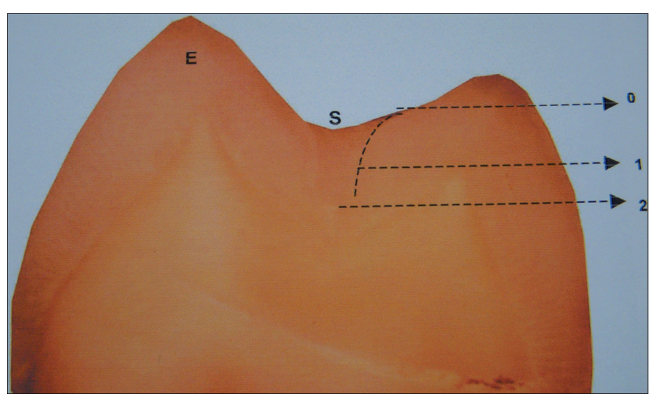

Figure 1: Diagrammatic representation of scoring system for penetration of dye (E, enamel; S,sealant)

Table 1: Frequency distribution of degree of microleakage

Score	Group I (n=20) (%)	Group II (n=20) (%)	Group III (n=20) (%)	Group IV (n=20) (%)	Group V (n=20) (%)	Group VI (n=20) (%)	Total % for each score
0	11 (55)	9 (45)	20 (100)	17 (85)	17 (85)	11 (55)	70.8
1	6 (30)	10 (50)	0 (0)	3 (15)	3 (15)	6 (30)	23.3
2	3 (15)	1 (5)	0 (0)	0 (0)	0 (0)	3 (15)	5.8

Figures in parenthesis indicate the % values. Group I, brushing only; Group II, pumice slurry; Group III, round bur (#1/4); Group IV, air polishing; Group V, air abrasion; Group VI, longer etching time

Table 2: Analysis of variance summary table comparing various groups (viz. groups I–VI) for microleakage

Source of variation	Sum of squares	Degree of freedom	Mean sum of squares	F ratio at 5% level of significance
Between	7.8	5	1.56	5.3087
Within	33.5	114	0.2933	
Total	41.3	119		

Table 3: "t" values for comparison between various groups

Groups compared	"t" value	Inference	P value
I–II	0.0000	Not significant	<0.05
I–III	3.5590	Highly significant	<0.001
I–IV	2.4008	Significant	<0.05
I–V	2.4008	Significant	<0.05
I–VI	0.0000	Not significant	<0.05
II–III	4.4853	Highly significant	<0.001
II–IV	2.8688	Very significant	<0.01
II–V	2.8688	Very significant	<0.01
II–VI	0.0000	Not significant	<0.05
III–IV	1.8311	Not significant	<0.05
III–V	1.8311	Not significant	<0.05
III–VI	3.5590	Highly significant	<0.001
IV–V	0.0000	Not significant	<0.05
IV–VI	2.4008	Significant	<0.05
V–VI	2.4008	Significant	<0.05

Similar results were obtained when pumice slurry [(Group II]) and longer etching [(Group VI]) and Air air polishing [(Group IV]) and Air air abrasion [(Group V]) when compared for microleakage were found to be not significant (t=0.0000; P<0.05).

When round bur group was compared with air polishing group and with air abrasion group, it showed no significance statistically (t=1.8311; P<0.05).

Comparisons between brushing only (Group I) and air polishing (Group IV), brushing only (Group I) and air abrasion (Group V), air polishing (Group IV) and longer etching time (Group VI), and air abrasion (Group V) and longer etching time (Group VI) gave significant results (t=2.4008; P<0.05).

Pumice slurry (Group II) when compared with air polishing (Group IV) and air abrasion (Group V), respectively, demonstrated very significant results, establishing them as better methods of preparation of occlusal surface (t=2.8688; P<0.01).

On comparing brushing only (Group I), pumice slurry (Group II), and round bur (Group III) with longer etching time (Group VI), the results showed high significance (t=3.5590, 4.4853, and 3.5590, respectively; P<0.001), statistically confirming the superiority of round bur as a method of preparation.

Discussion

The major finding of this study is that the bur preparation produced less microleakage and best results. Air abrasion and air polishing also produced better result than pumice slurry, bristle brush, and longer etching time tooth preparations.

Several reasons can be proposed for the finding: Fissures are widened and deepened, organic material and plaque is eliminated,[4] provides more surface area to retain the sealant, and a consistent plug of sealant is obtained which provides more wear resistance.[5] Enamel fissure penetration of the sealant is better when fissures are enlarged by bur and acid etching used.[6] Enlargement of fissures creates difficulty for implanting a stable microflora and establishing a closed system for the development of caries. Subsequent sealant placement decreases the number of viable bacteria up to hundred percent100%.[7]

Air abrasion and air polishing also showed better results because they allow complete removal of extrinsic stains and debris in a significantly lesser time.[8,9] This technology also minimizes heat, vibration, and bone conducted noise, thus reducing the need for anesthesia, which is helpful in the pediatric clinic.[10,11] These methods bombard abrasive particles to the surface, thus creating higher energy surface compared to smearing motion of rubber cup or bristle brush, thereby facilitating the effect of acid etching and resulting in higher bond strength.[12]

Brushing only and pumice slurry preparation methods have not been very effective means of surface preparation, the reason being residual debris and pellicle may not be removed from the base of the fissures, preventing enamel conditioning and decreasing the resin penetration.[8,13-15] Cleaning and preparation in these methods is confined to the cuspal inclined planes only and not to the base of the fissures.[14] The diameter of the bristle (0.2 mm) is too large to penetrate the orifice of most fissures measuring 0.1 mm wide.[16] Pumice particles become lodged and impacted into the fissures, become incorporated into the sealant, thus altering its micromechanical bond, causing greater microleakage.[9,13,14]

Clinical evidence also supports the findings of this investigation in a 6-year clinical trial done by Shapira and Eidelman; bur prepared sealants had 88% retention rates compared to 66% retention rate for conventionally prepared sealants.[4] It can be hypothesized that the greater retention can be due to enlargement of the pits and fissures, which produces a greater surface area for bonding and use of thicker layer of sealant which would be more resistant to wear.

The results observed in the present *in vitro* study suggest the following:

1. No microleakage was evident in round bur group. Therefore, superior results were obtained when occlusal surface was prepared mechanically using a round bur as compared to the other groups.
2. Air polishing and air abrasion groups showed similar good results. 85% showed Grade 0 microleakage.
3. Increasing the etching time to 60 seconds did not show any difference in results from the conventional method of preparation and 30-second etching group.
4. The application of air polishing and air abrasion showed better results than pumice slurry due to use of fine particles of abrasives at a higher speed.
5. The application of air polishing and air abrasion showed superior results than prophylaxis with bristle brush and longer etching time, unlike the latter which cleans only the cuspal inclines, the fine abrasive particles can penetrate up to the base of the fissures.

Conclusions

Round bur was the most successful cleaning and preparing technique. Air polishing and air abrasion produced significantly lesser microleakage than the traditional pumice slurry, bristle brush, and longer etching time.

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