ORIGINAL RESEARCH

Comparative Evaluation of Sealing Ability of Moisture-tolerant Sealant and Glass Ionomer Sealant Using Stereomicroscope: An *In Vitro* Study

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Abstract

Introduction/background: The preventive benefits of pit and fissure sealants rely on their retention and sealing ability. The drawback of the conventional pit and fissure sealant is its poor retention due to the presence of moisture. Among the numerous pit and fissure sealants available, newer hydrophilic sealants are ideal for children. This study evaluates and compares the sealing ability of hydrophilic sealant Embrace WetBond with conventionally used glass ionomer sealant under a stereomicroscope.

Materials and methods: A total of 48 extracted human premolars were randomly divided into two groups ($N = 24$) and sealed with Embrace WetBond and GC Fuji VII as per manufacturers' instructions. Following thermocycling, the sectioned samples were evaluated for sealant penetration, unfilled space, and total length of fissure under a stereomicroscope at magnifications 2.5×, 4×, and 5×. The values were measured in microns and in various fissure types using the "ImageJ app" to measure the sealant penetrability and sealing ability. The data recorded were statistically evaluated.

Results: The penetrability of moisture-tolerant sealant was better (87.8 ± 10.7) compared to that of glass ionomer sealant (73.8 ± 15.5) ($p = 0.002$). Among the samples, U-type fissure patterns displayed greater penetrability (94.2 ± 6.2), whereas IK-type fissures revealed the lowest degree of penetrability (67.5 ± 7.3).

Conclusion: Embrace WetBond is better than glass ionomer sealant with respect to penetrability and sealing ability under stereomicroscope hence recommended as a better sealant for pediatric clinical practice.

Keywords: Embrace WetBond, Fissure morphology, Pit and fissure sealant, Stereomicroscope.

International Journal of Clinical Pediatric Dentistry (2023): 10.5005/jp-journals-10005-2601

Introduction

Pits and fissures are more likely to develop dental caries than other surfaces on the occlusal (chewing) surfaces of posterior teeth because of its morphology which allows increased plaque retention, permeable immature enamel structure, and decreased fluoride effect on pits and fissures.[1] Epidemiological data suggest that pits and fissures, particularly in children, contributes to 80–90% of carious lesions,[2] of which 90% of carious lesions were in permanent teeth, and 44% in primary teeth caries were found to be of pit and fissure type.[3] Hence, there is a major need to protect the occlusal surfaces of teeth from the carious process.

The Cochrane systematic review has evidence-based studies suggesting the use of pit and fissure sealants for the prevention of caries in permanent teeth considering the sealant's effectiveness. Moisture contamination is a common challenge encountered in pediatric dentistry which compromises the quality of adhesion at the sealant-enamel interface.[4] To address this problem, hydrophilic sealants were introduced specifically to be placed on moist enamel. However, these two sealants are found to be technique sensitive with reduced chair side time and are most preferred for their use in primary teeth.

Among the various factors, sealant penetrability is considered extremely important for the success of treatment. The benefits of both fluoride-releasing glass ionomer and moisture-tolerant sealant will be compared *in vitro* under a stereomicroscope to assess which has better sealing ability among them.

There have been numerous studies comparing the retention,[5] remineralization effect,[6] and other properties of glass ionomer sealant with moisture-tolerant sealant. In a literature search, glass ionomer sealant (GC Fuji VII) and moisture-tolerant sealant (Embrace WetBond) have never been compared for their sealing ability. Therefore, the goal of the study is to evaluate and compare the sealing ability of moisture-tolerant sealant and glass ionomer sealant under a stereomicroscope.

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How to cite this article: Priscilla S, Shivashankarappa PG, Mohandoss S, et *al.* Comparative Evaluation of Sealing Ability of Moisture-tolerant Sealant and Glass Ionomer Sealant Using Stereomicroscope: An In *Vitro* Study. Int J Clin Pediatr Dent 2023;16(S-1):S67–S71.

Source of support: Nil

Conflict of interest: None

Materials and Methods

Sample Design and Sample Size

This is an *in vitro* comparative study. The sample size is calculated based on the review of literature[8] with significance level α = 0.05, and power = 90% was 48.

Collection of Teeth Samples

The sample comprised premolars extracted for orthodontic purposes with intact crown structure. Teeth with caries, fractures, cracks, hypoplasia, restoration, attrition, and malformed teeth were excluded.

Sample Preparation

Distilled water was used as a storage medium for extracted teeth, as it keeps specimens hydrated to minimize resin shrinkage and does not alter the protein structure and enamel structure. A rubber cup at a slow speed with a contra-angle handpiece along with pumice slurry was used to clean the occlusal surface of each tooth. Air water spray was used to rinse the pits and fissures, and air dried them. Samples were mounted in a plastic block using cold cure resin so that only the crown portion was exposed.

Sealant Application

The teeth specimen were randomly allocated into two groups. In one group, after conditioning the occlusal surface of the samples, the GC Fuji VII glass ionomer cement capsule was applied and light cured. In other groups, 38% phosphoric acid gel (EtchRite gel) was used to etch the occlusal surfaces of all the samples and the sealant Embrace WetBond was applied and cured.

Thermocycling

Thermocycling was subsequently done after sealant application, which is done to simulate the oral environment. In the present study, 500 cycles of thermocycling between 5 and 55°C were performed for 60 seconds in each bath with a transfer period of 3 seconds.

Sectioning of Teeth Samples

After thermocycling, the teeth's crown embedded in self-cure acrylic resin was sectioned longitudinally buccolingually from the central fossa using hard tissue microtome (LEICA SP 1600) under water coolant into sections of 100 μ thickness.

Stereomicroscopic Evaluation

The stereomicroscope (ZEISS Stemi 508) was used to examine the sectioned samples at three magnifications (2.5×, 4×, and 5×) (Figs 1 and 2) for fissure morphology, sealant penetration depth, length of unfilled space, and total fissure length than the photomicrographs of each section was taken in each of the magnification for image analysis (Fig. 3).

Image Analysis

The stereomicroscopic images were analyzed using the software ImageJ app (ImageJ, National Institutes of Health, Bethesda, United States of America). The sealant penetration depth, length of unfilled space and total length of fissure were measured in microns from photomicrographs using the ImageJ app.

The sealing ability was evaluated based on penetrability, which is calculated from sealant penetration depth, length of unfilled space, and total fissure length.

Penetrability = Sealant penetration depth/Total fissure length × 100

Fig. 1: Stereomicroscopic image of glass ionomer sealant in I-type fissure at 5× magnification

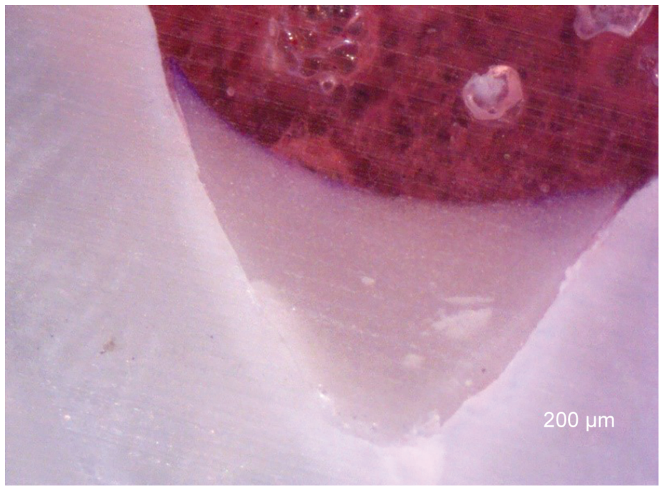


Fig. 2: Stereomicroscopic image of moisture-tolerant sealant in U-type fissure at 5× magnification

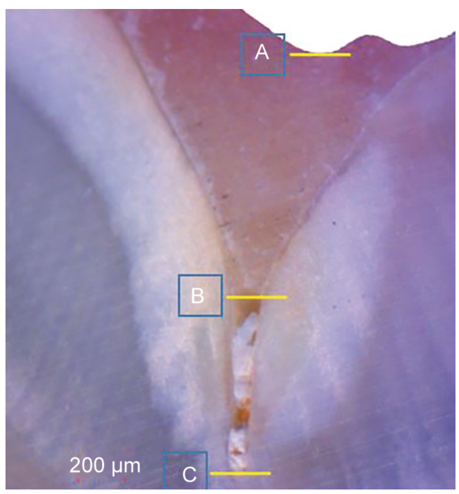


Fig. 3: Points of reference used to determine the depth of sealant penetration and penetrability of sealant, where A denotes the deepest point on the concavity of the upper margin of occlusal sealant; B—base of sealant; C— base of the fissure

Measurements of a photomicrograph of each section in all three magnifications were measured, and the mean value of the readings was considered to calculate the sealing ability of the sealant. Data obtained were subjected to statistical analysis.

Results

In this study, the mean value of penetrability for Embrace WetBond was 87.8 ± 10.7, which was found superior to GC Fuji VII 73.8 ± 15.5, respectively ($p = 0.002$) (Table 1). The fissure length that is left unfilled after sealant application is less for groups sealed with moisture-tolerant sealant than for groups sealed with glass ionomer sealant ($p = 0.001$).

In this study, the results show higher penetrability for fissure type "U" (94.2 ± 6.2) followed by fissure type "V" (84.7 ± 12.4), fissure type "I" (71.8 ± 15.8), and fissure type "IK" (67.5 ± 7.3) (Table 2 and Fig. 4). The penetrability was significant between the two groups in the "I" type fissure using Mann–Whitney *U* test ($p = 0.045$), whereas not significant between the "U" type, "V" type, and "IK" types of fissures. On assessing the sealing ability of each sealant in each morphology, the penetrability of moisture-tolerant sealant in V type fissure is 89.8 ± 2.8 and glass ionomer sealant is 79.5 ± 3.7 whereas in I type fissure, the penetrations are 81.6 ± 4.8 and 65.1 ± 5.0, respectively.

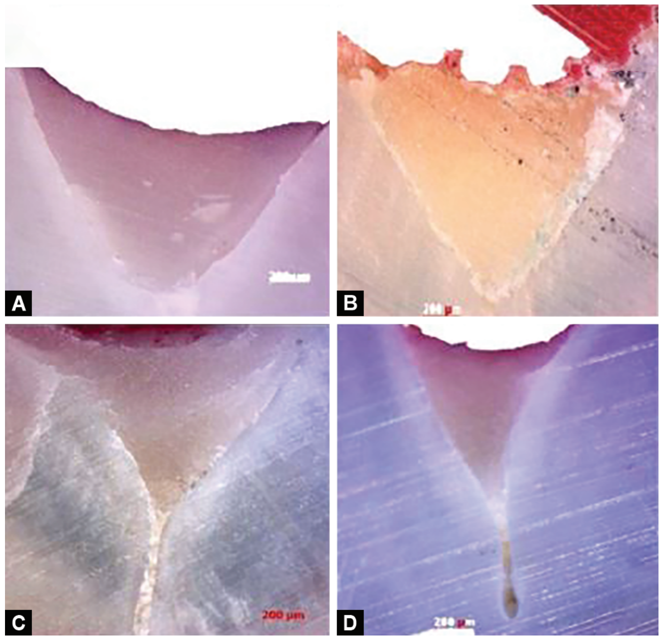
Discussion

The primary objective of dental sealants is to achieve extensive penetration inside pits and fissures in order to improve retention and reduce exposure to cariogenic microorganisms. The retention of sealant and the sealing ability of pit and fissure sealant are important factors in preventing dental caries. The sealant retention may be dependent on the penetration depth. In this study, the sealing ability is measured on the basis of penetration depth. Factors such as the morphology of fissures and properties of materials have been suggested to have an influence on the ability of pit and fissure sealants to penetrate.

In light of the aforementioned factors, this *in vitro* study was conducted to evaluate the sealing ability of moisture-tolerant resin-based sealant (Embrace WetBond) with glass ionomer sealant (GC Fuji VII) using a stereomicroscope. A total of 48 premolars extracted for orthodontic purposes having no caries, developmental defects, enamel microfractures, and discoloration were included. The extracted premolars were stored in distilled water until further use. In our study, we opted to employ pumice prophylaxis with a rubber cup to clean the occlusal surfaces of premolars before etching.

Stereomicroscope is the gold standard used in evaluating the sealing ability in most studies and hence chosen in our study. In previous similar stereomicroscopic studies,[7,8] three values were taken in the same magnification, and the mean value was taken as the representative value. Here, there is more chance of observational error, and the value may not be accurate. In our study, both low and high magnification up to 5× is used to help in centering and focusing the morphology and base of the pit and fissure. In our study, measurements in three different magnifications of the stereomicroscope were taken for more accurate representative values.

Our study shows better penetrability of Embrace WetBond sealant (87.8 ± 10.7) compared to glass ionomer sealant (73.8 ± 15.5). The penetrability was dependent on the depth of penetration of the



Figs 4A to D: (A) Denotes U-type fissure morphology; (B) V-type fissure morphology; (C) I-type fissure morphology; (D) IK-type fissure morphology

Table 2: Relationship between fissure form and penetration

Fissure form	*N (%)*	*Penetration (μ)*	*p-value*
U	12.5	94.2 ± 6.2	0.380
V	50	84.7 ± 12.4	0.057
I	31.3	71.8 ± 15.8	0.045*
IK	6.3	67.5 ± 7.3	0.221

*Denotes statistically significant at $p < 0.05$

Table 1: Summary of penetrability of moisture-tolerant sealant and glass ionomer sealant

Variables	*Group*	*N*	*Mean ± standard deviation (μ)*	*p-value*
Sealant penetration depth	I	24	1068.3 ± 304.5	0.496
	II	24	1012.3 ± 359.9	
Length of unfilled space	I	24	424.3 ± 326.7	0.001*
	II	24	146.9 ± 147.0	
The total length of the fissure	I	24	1492.6 ± 462.7	0.007*
	II	24	1159.3 ± 392.6	
Penetrability	I	24	73.8 ± 15.5	0.002*
	II	24	87.8 ± 10.7	

Group I—glass ionomer sealant; group II—moisture-tolerant sealant; *denotes statistically significant at $p < 0.05$

material and the length of unfilled space in the total fissure length. The better penetrability of Embrace WetBond correlate with studies done by Aranda et al.,[9] comparing Embrace WetBond to Delton FS in sealing ability and by Iyer et al.,[10] comparing Embrace WetBond with conventional resin-based sealant Seal-Rite. The studies by Garg et al.,[7] and Muntean et al.,[8] are contrary to glass ionomer sealant having better penetrability.

The pit and fissure sealant's penetration ability is indirectly proportional to its viscosity; in glass ionomer sealant, due to its greater viscosity, there is incomplete sealant penetration to the bottom of the pit and fissures, which decreases the retention of the sealant. Similarly, Prabhakar et al.,[11] in their study, concluded that Embrace WetBond was found to have less viscosity because of urethane monomer offering more elasticity and adhesiveness to resin-based sealant, thereby more sealant flow and penetration.

The lateral wall adaptation of the sealants was assessed, and on comparison, the adaptation was found to be more in moisture-tolerant sealant (91.7%), whereas less in glass ionomer sealant (70.8%).

Based on Fissure Morphology

In this research, fissure type is classified according to the Nagano classification of occlusal fissure mentioned in the article. The morphology of the fissures has an important influence on the sealant material's penetration,[12,13] which in turn affects the sealing ability. Fissure morphology had an effect on sealing ability in this research, with U-shaped fissures showing better sealing ability, albeit there were no statistically significant variations in sealant penetrability between the two groups ($p > 0.05$). U-type fissures and V-type fissures displayed greater penetrability, whereas IK-shaped fissures revealed the lowest degree of penetrability. The penetrability in each morphology is assessed to find which sealant has the better sealing ability as the less sealing ability allows microleakage, which in turn leads to caries development below the sealant. These results are in agreement with studies conducted by Muntean et al.,[8] and Garg et al.,[7] with significantly greater penetration for two types of sealants evaluated in U-type fissures. Radhakrishnan et al. confirmed that sealant penetration in U-type fissures and V-type fissures is comparatively more than in I-type and IK-type, which is in agreement with the present study.[10]

The reduced penetrability in deep constricted fissures such as IK type may be due to the residual material in the fissure after pumice prophylaxis or air entrapment. Grewal and Chopra suggests the use of prophylaxis paste or abrasive brush without pumice slurry to prevent plugging of any residual material in fissure space and invasive techniques for preparation of deep constricted fissure area for sealant placement.[14]

There is limited literature evidence on comparing glass ionomer sealant and Embrace WetBond in terms of sealing ability in different fissure morphologies. This *in vitro* study was conducted against this background, and the results of our study suggest that the overall depth of penetration of the moisture-tolerant sealant group is >70% of the total depth of the fissure while only 58% glass ionomer group had >70% of the total depth penetration.

Limitations

- The investigator had no influence over the fissure form distribution because the study samples were gathered until the sample size criteria were reached.
- After glass ionomer sealant placement in the occlusal pits and fissures, proper finishing and polishing are required because of its irregular upper surface compared to the smooth upper layer in moisture-tolerant sealant.
- The present study was carried out in *in vitro* conditions in premolars, so moisture control was easy to achieve. Further *in vitro* studies can be done in primary molars to know their effectiveness in the primary dentition.
- *In vivo* investigation and long-term clinical studies with larger sample sizes are necessary as the clinical performance of the sealant will vary according to changes in oral condition and patient performance.

Conclusion

The following conclusions have been drawn within the parameters of this *in vitro* study:

- The sealing ability of Embrace WetBond moisture-tolerant pit and fissure sealant was better than GC Fuji VII glass ionomer sealant evaluated under stereomicroscope.
- The sealing ability of pit and fissure sealants compared was found to be better in U-type fissure pattern followed by V-type, I-type, and then in IK-type in premolars under a stereomicroscope.
- The lateral wall adaptation of moisture-tolerant sealant was found to be superior to glass ionomer sealant.
- Better sealing ability of Embrace WetBond makes it a better material of choice to be used in regular pediatric clinical practice.

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