

Comparative Evaluation of the Marginal Sealing Ability of Fuji VII® and Concise® as Pit and Fissure Sealants

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Abstract

Aim: The anatomical pits and fissures of the teeth have long been recognized as susceptible areas for the initiation of dental caries. The extreme vulnerability to decay of these pits and fissures on the occlusal surfaces has prompted dental scientists to seek methods of caries prevention. Motivated by the role of pit and fissure sealants in caries prevention, the aim of this study was to compare the efficacy of Fuji VII® glass ionomer sealant and Concise® resin-based sealant.

Methods and Materials: An *in vitro* study was undertaken using forty premolars extracted for orthodontic reasons. The teeth were divided into two groups and sealants were applied. One was an experimental group using Fuji VII® as a pit and fissure sealant and the other a control group using Concise®. The teeth were kept in gentian violet dye for 24 hours, the sectioned samples were observed for the extent of dye penetration, and scores were based on established scoring criteria.

Results: The comparison of the performance of the two groups showed a statistically significant difference.

Conclusion: The Concise® resin-based sealant performed better in terms of sealing ability than did the Fuji VII® glass ionomer sealant.

Keywords: Sealant, marginal leakage, pit and fissure, laser spectroscopy

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Introduction

The anatomical pits and fissures of the teeth have long been recognized as susceptible areas for the initiation of dental caries. The extreme vulnerability to decay of these pits and fissures on the occlusal surfaces has prompted dental scientists to seek methods of caries prevention.

In the sheltered environment of pits and fissures, the caries process can quickly initiate and advance. While both systemic and topical fluorides protect teeth from decay, the relative effectiveness of fluoride is less in pit and fissure areas. Robertson¹ has stated occlusal surfaces with pits and fissures are prone to dental caries. At present, the maintenance of oral hygiene in conjunction with fluoride therapy and the prudent use of pit and fissure sealants seems to be the best caries prevention strategy.² This is very significant in developing countries characterized by the predominance of the child and adolescent sectors of the population (almost 40% of the total population). This, along with a lack of dental manpower, limits access to care by the masses.³

In a developing country like India the low dentist to population ratio makes preventive measures more imperative. The initial cost of preventive measures like sealants might exceed the cost of some restorative materials. However, on a long-term basis sealants or any other preventive measure is more cost effective as the teeth are being maintained in a state of health.

For a variety of reasons, pit and fissure sealants have not been widely accepted by the dental profession despite overwhelming evidence in support of their caries preventive potential. The primary problems associated with sealants are lack of retention of the sealant or microleakage leading to the deterioration of the material itself which increases potential for the development of caries. Several studies have been done to compare resin and glass ionomer sealants.^{4,5} Recently, Fuji VII[®] (GC Corporation, Tokyo, Japan) glass ionomer pit and fissure sealant has been introduced to the Indian market with claims of having all the properties of an ideal sealant material; however, no independent scientific studies have been conducted on this material to date. Due to the importance of the role of pit and fissure sealants in caries prevention, this



study was undertaken to compare the efficacy of Fuji VII[®] and Concise[®] (3M ESPE Dental Products, St. Paul, MN, USA), a resin-based material, as sealant materials.

Methods and Materials

Sample Size

This study was carried out in collaboration with the Indian Institute of Science in Bangalore, India. Forty healthy, non-hypoplastic, non-carious premolars extracted for orthodontic reasons were selected for the study and were divided into the following two groups:

Group I: Twenty teeth for application of Fuji VII[®] glass ionomer sealant (experimental group).

Group II: Twenty teeth for application of Concise[®] resin-based sealant (control group).

Sealant Materials Used

The following pit and fissure sealant materials were used in the study:

1. Concise[®] - Light yellow (3M ESPE, Bangalore, India) along with single-tufted brushes, etchant, and disposable tips.
2. Fuji VII[®] - Pink (GC Corporation, Tokyo, Japan.) along with a plastic mixing spatula, measuring scoop, mixing pads, and varnish.

Sample Preparation

All forty samples were polished with pumice to remove any residual plaque or stains, especially from the occlusal surfaces, and stored in artificial saliva at room temperature (32-36°C) in the tropical climate of Manipal, India. Artificial saliva was prepared by the College of Pharmaceutical Sciences in Manipal, India following the composition recommended by Sieck et al.⁶

Sealant Placement

Prior to placement of the sealant an acid resistant varnish coating was applied on all surfaces of the teeth except on the occlusal surface where sealants were to be placed. Sealant placement was carried out using the material corresponding to the appropriate study group and according to the manufacturer's instructions using the following steps:

Group I (Fuji VII[®])

1. Plaque was removed from the pits and fissures, and the area was carefully cleaned with a cone-shaped brush in a slow speed hand piece under running water.
2. The application area was rinsed with water, and the tooth surface was gently dried using an air syringe as instructed by the manufacturer making sure not to desiccate the surface.
3. Mixing of the sealant material was done according to the manufacturer's instructions.
4. An accessory applicator provided in the sealant kit was used to apply the mixed cement into the pits and fissures.
5. The tip of the curing light was held at a distance of 1 mm vertical to the sealant surface and activated for 20 seconds.

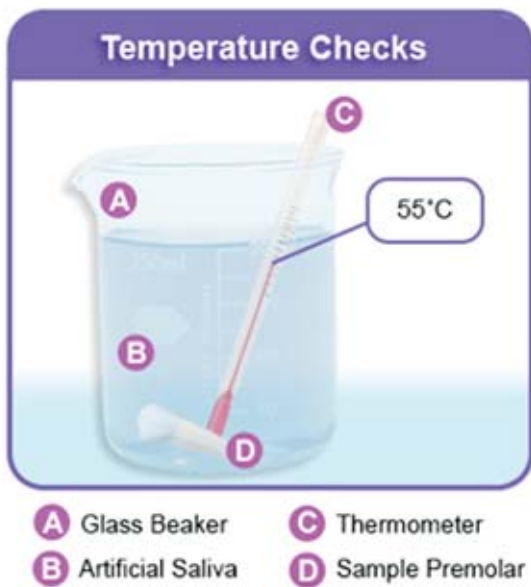
6. When the sealant material lost its gloss, Fuji Varnish was applied to its surface and to adjacent areas using the accessory sponge provided for this purpose. The area of application was gently dried with an air syringe. This was done for surface protection of the sealant material during initial stages of setting because it is moisture sensitive.

Group II (Concise[®])

1. Tooth surface cleaning was done using a polishing cone-shaped brush in a slow speed hand piece while applying a constant stream of water.
2. Pits and fissures were thoroughly cleaned using an explorer probe.
3. Etchant gel was dispensed onto the mixing plate then a small disposable brush was used to apply the gel to the occlusal surface. The etchant was allowed to remain in place for about 15 seconds, and the tooth was then flushed with water for 15 seconds again to remove all of the etchant. The tooth was then dried thoroughly to achieve a complete frosty white appearance.
4. The sealant applicator nozzle was attached to the dispenser, and the tip was bent for easy access and convenient handling. Then the applicator nozzle was placed against the etched area of the tooth pits and fissures while the barrel of the applicator was gently squeezed for precise resin placement.
5. The tip of the curing light was held vertical to the resin surface at a distance of about 1 mm then the sealant was light cured for 20 seconds.

Thermocycling

Thermocycling was carried out at the Department of Biochemistry, Manipal. The purpose of thermocycling was to simulate the oral environment. All the groups were subjected to thermocycling at 5°C, 37°C, and 55°C for 250 cycles with a dwell time of 30 seconds and stored for 15 days in artificial saliva before being tested for microleakage and bond strength. A glass beaker immersed in a box of ice was used to maintain the temperature at 5°C, a hot water bath was used to maintain the temperature at 37°C, and an incubator was used to maintain the temperature at 55°C. A thermometer was placed to check the temperature periodically,



and care was taken to ensure that all the teeth were completely immersed in artificial saliva. Immersion time was recorded using a stop watch.

Dye Penetration

The samples were immersed in a 2% alcohol gentian violet solution for 24 hours. After removal, all the samples were placed in plain water to remove excess dye and were air dried. The root portions of the samples were removed then the crown portions were sectioned buccolingually into two halves using a carborundum disc mounted on a straight handpiece with a continuous flow of water. The sectioned samples were examined under a Leica Model No. SU-30 laser spectroscope (Leica Microsystems GmbH, Wetzlar, Germany), and photomicrographs were taken to evaluate the extent of dye penetration. The Williams and Winter⁷ criteria for evaluation of dye penetration was used and is described as follows:

Grade 0: No dye penetration.

Grade 1: Dye penetration extending one third the total length of the interface between the sealant and tooth structure.

Grade 2: Dye penetration extending between one third and two thirds the total interface length.

Grade 3: Dye penetration extending beyond two thirds of the total interface length.

Results

When the two groups were compared in terms of the extent of microleakage, four of 20 samples (20%) had no dye penetration (Grade 0) in Group I, while nine of 20 samples (45%) were Grade 0 in Group II. Group I also had the most extensive dye penetration (Grade 3) in eight of 20 samples (40%). On the other hand, Group II had only one of 20 samples (5%) in the Grade 3 category. It should be noted one sample in both groups was undecided (Table 1). Examples are shown in Figures 1 and 2.

On comparison of the microleakage scores of the groups, a very high statistically significant difference was found between the two groups with a "p" value of 0.001 indicating a much better performance of Concise® as compared to Fuji VII® (Table 2). Examples are shown in Figures 3 and 4.

Discussion

During the past thirty years significant emphasis has been placed on the prevention of dental caries which is the principle dental disease afflicting mankind. The primary prevention strategies available are use of systemic and topical fluorides, plaque control, and the use of fissure sealants. Though use of fluorides has been shown to be very effective, their relative effect is seen to be least for pits and fissures.⁸

Table 1. Microleakage scores in the Fuji VII® (glass ionomer) and Concise® (resin-based) sealant groups.

SCORE	Fuji VII® (Group I: Experimental)		Concise® (Group II: Control)	
	Sample (No.)	Sample (%)	Sample (No.)	Sample (%)
GRADE 0	4/20	20%	9/20	45%
GRADE 1	3/20	15%	6/20	30%
GRADE 2	4/20	20%	3/20	15%
GRADE 3	8/20	40%	1/20	5%

Note: One sample was undecided in both groups.



Figure 1. Spectroscope image showing Grade 0 using Fuji VII®.

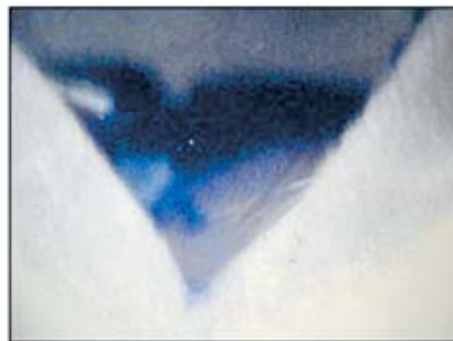


Figure 2. Spectroscope image showing Grade 3 in Concise® sealant.

Table 2. Intergroup comparison of microleakage scores between the Fuji VII® (glass ionomer) and Concise® (resin-based) sealant groups.

Scores	Sample Size	Mean Rank	X ² /df	P-Value
Grade 0	18	29.17	33.388/3	.001HS
Grade 1	12	15.00		
Grade 2	6	4.50		
Grade 3	2	4.50		

Legend: X²: Chi-square; df: Degree of freedom; HS: Highly significant



Figure 3. Spectroscope image showing Grade 3 using Fuji VII®.



Figure 4. Spectroscope image showing Grade 0 in Concise® sealant.

The rationale of using sealants is to penetrate and seal off caries-prone pits and fissures from the oral environment. As a result, the cariogenic microorganisms present in these fissures lose their viability.⁹ In this era of preventive dentistry several dental materials designed for the prevention of dental diseases are available. The latest generation of pit and fissure sealants has the added advantage of having fluoride incorporated into them.

There are many factors that contribute to a successful sealant restoration such as properties of enamel, duration of etching, the acid used in etching, and other manipulative variables. However, the primary factor influencing the efficacy and life expectancy of a sealant is favorable marginal adaptability to enamel in order to form a seal and minimize microleakage.¹⁰ A marginal seal relies on the retention of the sealant material.

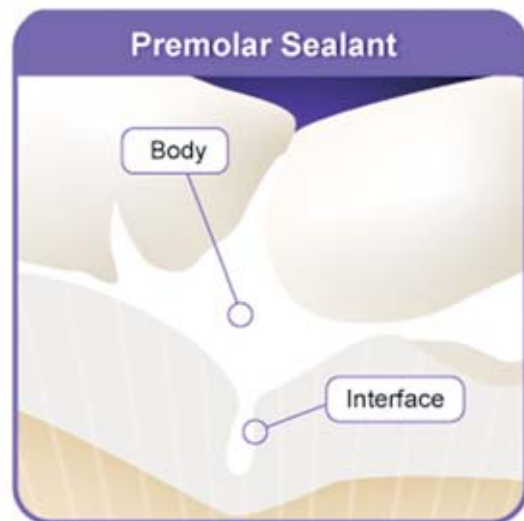
The present study used forty healthy, non-carious premolars extracted for orthodontic reasons to evaluate the microleakage. The teeth were randomly cleaned after extraction, divided into two groups, and stored in artificial saliva. Group I served as the experimental group and consisted of 20 teeth sealed with Fuji VII[®] glass ionomer. Group II served as a control group of 20 teeth sealed with Concise[®] resin-based sealant as this material is a well proven and an efficacious sealant material.¹¹⁻¹² Both groups were then thermocycled under the same conditions to simulate the oral environment.

Thermocycling was carried out to subject the materials and teeth to the extremes of temperature seen in the oral cavity, thus, simulating the natural oral environment. Shortall¹³ suggested a range of temperature from 0°C to 68°C for thermocycling. In the present study thermocycling temperatures of 5°C, 37°C, and 55°C were used because the range covers the extremes of temperature to which the oral cavity is subjected. Thermocycling using 250 cycle series supported by Smith et al.¹⁴ was carried out in the present study with a dwell time of 30 seconds suggested by Bullard & Leinfelder.¹⁵ Smith et al.¹⁴ noted there is no significant difference in microleakage between 250 and 500 cycles.

The use of organic dyes as tracers has been one of the oldest and most popular methods of detecting microleakage (Shortall).¹³ However, the subjective nature of the assessment must be taken into account since numerical values are assigned to different degrees of microleakage. The samples were evaluated for microleakage under a laser spectroscope because it gives a greater depth of focus, long working distance, and simplicity of operation.

The results obtained in the present study showed a higher degree of leakage in Group I using Fuji VII[®] glass ionomer sealant as compared to the Concise[®] resin-based sealant. This difference in leakage pattern could be due to the weakness of glass ionomer at the tooth-sealant interface resulting in the inability to resist leakage of the test dye. There are no published studies testing the marginal sealing ability of Fuji VII[®], a relatively new glass ionomer material. But studies comparing glass ionomer cements (GICs) with resin have shown a higher degree of dye penetration in GICs as reported by Kidd.¹⁶ This could be due to the existence of some gap between the tooth and the sealant at the tooth-sealant interface which allowed ingress of fluids like the test dye. Dhar and Tandon¹⁷ found greater gaps existing between the tooth and the sealant at the interface in GIC than in resin-based sealants.

Most of the dye penetration in the present study occurred through the interface and not through the body of the cement in contrast to the results obtained by William and von Fraunhofer,¹⁸ who



found more dye penetration through the body of the cement. This could be due to the improved qualities of new generation GICs which create a higher cohesive strength between the materials as compared to earlier GICs.

In the present study resin-based sealant (Concise[®]) appeared more resistant to dye penetration although some degree of dye penetration could be seen at the interface. This may be due to the etching of the enamel surface which produces a noticeable improvement in the interfacial contact between the resin and enamel with a notable reduction in the contact angle indicating there is improved wet-ability of the enamel.¹⁹ It could also be because low molecular weight entities and viscous fluids leach out of the sealant and combine with the enamel at the sealant tooth interface sealing it against ingress of fluids. Williams and Winter⁷ also noted a

similar finding in their study conducted on five pit and fissure sealants. Micromechanical retention provided through porosities maximizes the surface area of bonding.²⁰

A resin-based sealant such as Concise[®] has a low viscosity, which is maintained until it is cured with light. This allows better penetration into the microspaces and establishes a bond with a deeper enamel layer.²¹ Thus, there was a very high statistically significant difference in the performance of the materials in terms of microleakage.

Conclusion

The Concise[®] resin-based sealant group (Group II) performed much better with less microleakage than did the Fuji VII[®] group (Group I).

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