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Research Article

# COMPARATIVE EVALUATION OF MICROLEAKAGE AROUND HELIOSEAL-F, IONOSEAL, DYAD FLOW AS A PIT AND FISSURE SEALANT: AN IN VITRO STUDY

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**ABSTRACT**

**Background:** Sealant application is a safe and effective way to prevent dental caries. The success of sealant application depends on the good isolation, patient corporation, and the decrease step for the application of sealant.
**Aim:** This study aims to evaluate and compare three different pit and fissure sealants to check their effectiveness for sealing ability and microleakage.
**Materials and Method:** 30 freshly extracted maxillary premolars extracted due to orthodontic purposes were selected to be sealed with composite based pits and fissures sealant (Helioseal F and Ivoclar Vivadent), resin-based glass ionomer (Ionoseal, Voco), self-adhering flowable composite (Dyad Flow, Kerr); respectively group I, II, III (n=10). All specimens were thermocycled at 50C-550C for 500 cycles with a dwell time of 30 seconds. Then immersed in methylene blue dye solution (24Hr) and longitudinally sectioned in a buccolingual direction to get a 1.5 mm thick specimen.
The percentage of microleakage was recorded according to Colley *et al*'s(1990) Scoring criteria under a stereomicroscope at 20X magnification as follows: Score 0: No marginal penetration by the dye. Score 1: Marginal penetration of dye along with the enamel sealant interface. Score 2: Dye penetration to a depth of sealant. Data were recorded and analyzed statistically.
**Statistical analysis used:** The frequencies of different microleakage scores were compared across different study groups using the chi-square test. The descriptive of the microleakage score were compared across groups using the Kruskal Wallis test & Mann Whitney U test (for post hoc pairwise comparison).
**Results:** Group III (self-adhesive composite) shows the least microleakage score.
**Conclusions:** Self-adhering flowable composite could be used in place of the composite-based pit and fissure sealants.



## INTRODUCTION

Pits and fissures of teeth have been recognized as the most susceptible areas for the initiation of caries.[1] The ability of the resin sealant to fill thoroughly pits, fissures, and morphological defects and remain completely intact and bonded to enamel surface is one of the methods for caries prevention. The clinical efficacy of pit and fissure sealants are directly related to their retention which depends on the morphology of pit and fissures, adequate isolation, material characteristics, application techniques.[2] Microleakage or marginal leakage may be defined as the ingress of oral fluid into the space between the tooth and restorative material.[3] So, the ability of a sealant to prevent microleakage is important. Microleakage is considered as the main problem with direct restorative procedures and one of the main reasons for restoration failure.[4] Different types of pit and fissure sealants used in dentistry are GIC based and resin-based. Resin-based sealant requires etching and bonding: multiple steps. Recently self-adhering composites are introduced. Hence this in-vitro study is to observe the microleakage around different types of pit and fissure sealants and self-adhering flowable composite resin as a pit and fissure sealant.

The aims of this study are to evaluate the adaptation and microleakage of composite-based sealant, resin-based glass ionomer sealant, self-adhering composite resin, and compare these three different pits and fissure sealants.

## MATERIALS AND METHOD

Ethical clearance of this current in-vitro study was attended by the Institutional Ethical Committee. Total freshly extracted thirty maxillary premolar teeth devoid of any caries, non-carious lesions like attrition, abrasion, erosion, abfraction,

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teeth with decalcification and fluorosis, any kind of restoration or anomalies, extracted for orthodontic purpose were collected. The sample size was decided based on the pilot study done with four samples used per group using Open Epi, version. The samples utilized in the pilot study were discarded.

Extracted teeth were cleaned of calculus and soft tissue remnants employing a hand curette and were disinfected using 0.5 % sodium hypochlorite for at least 30 minutes and rinsed with distilled water as per the Occupational Safety and Health Administration recommendation guidelines. The teeth were stored in normal saline at $4^0$ C until use in a beaker.

Cleaning of occlusal fissure surfaces was done by a pumice slurry with a low-speed micro motor handpiece with a polishing brush.[5]

The teeth were randomly divided into three groups (I-III) with ten teeth in each group according to the pit and fissure sealant placement:

1. Group I: Helioseal-F, Ivoclar Vivadent; Composite based sealant (n=10)
2. Group II: Ionoseal, Voco; Resin-based glass ionomer sealant (n=10)
3. Group III: Dyad Flow, Kerr; Self-adhesive composite (n=10)

The samples have been prepared by following methods:

In Group I, occlusal fissure surfaces of teeth were etched with 37% phosphoric acid gel for 30 seconds. Then the etched surfaces were rinsed with water spray for 10 seconds and dried with oil-free air. The material (Helioseal-F, Ivoclar Vivadent) was applied directly to the occlusal surfaces of the teeth according to the manufacturer's instructions. Care was taken not to incorporate air bubbles and if present, they were removed with an explorer. The material was light-cured for at least 20 seconds using a visible light-curing unit (Coltolux, Coltene).

In Group II the material (Ionoseal, Voco) was applied into the fissures without etching and bonding agent application according to the manufacturer's instruction and then light-cured for at least 20 seconds.

In Group III the material (Dyad Flow, Kerr) was applied directly in the pits and fissures without etching and bonding protocol before placement.

The samples are then restored in normal saline at room temperature for 24 hours. The restored teeth were then thermocycled at 5 °C and 55 °C for 500 cycles with a dwell time of 30 seconds.

All the specimens were triple coated with nail varnish except 1mm around the sealant margins and the apex of teeth was sealed with sticky wax. The teeth were then immersed in a 10% aqueous solution of methylene blue dye solution for 24 hours following which the samples were washed thoroughly under tap water to remove the superficial dye. The root portion of teeth was cut at the level of a cementoenamel junction and then the crown portion of the samples was sectioned longitudinally in a buccolingual direction through the middle of the sealant using a diamond disk with a slow speed (25000 rpm) handpiece under the copious amount of water coolant to avoid friction. The sample thickness was 1.5 mm which was measured by a vernier caliper.

The degree of microleakage was scored under a stereomicroscope with a magnification of 20X using criteria by Colley *et al* (1990) as follows:[6]

Score 0: No marginal penetration by the dye.
Score 1: Marginal penetration along with the enamel sealant interface.
Score 2: Dye penetration to a depth of sealant.
The collected scores were tabulated and statistically analyzed

***Statistical Analysis***

Data were analyzed using Statistical Package for Social Sciences (SPSS, version 16). The frequencies of different microleakage scores were compared across different study groups using the chi-square test. The descriptives of the microleakage score were compared across groups using the Kruskal Wallis test & Mann Whitney U test (for post hoc pairwise comparison). The level of statistical significance was set at 0.05.

## RESULTS

| | | | Microleakage score | | | Total |
|---|---|---|---|---|---|---|
| | | | Score 0 | Score 1 | Score 2 | |
| Group | Group I | n | 6 | 3 | 1 | 10 |
| | | % | 60.0% | 30.0% | 10.0% | 100.0% |
| | Group II | n | 5 | 3 | 2 | 10 |
| | | % | 50.0% | 30.0% | 20.0% | 100.0% |
| | Group III | n | 10 | 0 | 0 | 10 |
| | | % | 100.0% | 0.0% | 0.0% | 100.0% |
| | Total | n | 21 | 6 | 3 | 30 |
| | | % | 70.0% | 20.0% | 10.0% | 100.0% |
| Chi-square, degrees of freedom | | | 7.000, 4 | | | |
| P-value | | | 0.136, NS | | | |

Among Group III, no specimen showed any type of microleakage, while among Group I, the majority of specimens i.e., 60% of teeth, did not show any microleakage, while 30% showed Score 1 & remaining 10% specimens showed Score 2. Among Group II, the majority of specimens i.e., 50% of teeth, did not show any microleakage, while 30% showed Score 1 & the remaining 20% specimens showed Score 2. The distribution of different microleakage scores was not found to be significantly (p=0.136) different among the three study groups.

| Descriptives of Microleakage score | | | | | | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | |
| | | | | | Lower Bound | Upper Bound |
| Group I | 10 | .5000 | .70711 | .22361 | -.0058 | 1.0058 |
| Group II | 10 | .7000 | .82327 | .26034 | .1111 | 1.2889 |
| Group III | 10 | .0000 | .00000 | .00000 | .0000 | .0000 |
| Chi-square, degrees of freedom, P-value | 6.364, 2,0.042, S | | | | | |
| Post hoc pairwise comparison | Group I v/s Group II : 0.584, NS<br>Group I v/s Group III: 0.03, S<br>Group II v/s Group III: 0.013, S | | | | | |

When descriptives of microleakage scores were compared across different study groups, then a statistically significant difference (p=0.042) was found. Post hoc pairwise comparison demonstrated that the mean microleakage score among Group III specimens was found to be significantly lower than that among Gr I (p=0.03) & Gr II (p=0.013).

## DISCUSSION

Microleakage is a significant problem in the interphase of tooth structure and restoration and can lead to postoperative tooth hypersensitivity, marginal discoloration, secondary caries, pulpal injuries, and fracture of restorations.[7] Pit and fissure sealant is one of the methods to prevent dental caries. Optimal adaptation of the sealant with enamel is very important since microleakage at the tooth-material interface can lead to treatment failure.

Bond strength and marginal leakage of restorative materials are usually investigated in vitro.[4] An ideal restorative material should provide high bond strength and minimal leakage.

Various methods are used to evaluate microleakage in in-vitro such as radioactive isotopes, chemical markers, neutron activation analysis, penetration of bacteria, scanning electron microscopy, electrical conductivity, and dye penetration methods. The dye penetration method is a widely used technique, which is non-toxic and inexpensive to detect even small amounts of leakage. In comparison with bacterial penetration, the dye penetration method is more accurate because the dye particle diameters are less than those of bacteria and they are the same size as the bacterial endotoxins. Therefore, the dye penetration method was used in this study to evaluate microleakage.[8,9]

Earlier it was recognized that in the development of the acid etch technique, isolation was a very critical element for the successful application of a pit and fissure sealant. There is a significant reduction in bond strength if the enamel, contaminated with saliva, is not washed off thoroughly.[10] Saliva produces an organic film that can penetrate the enamel microporosities which is created by acid etching and, thereby interfering with the bonding of the sealant material into the etched enamel.[11]

The clinical limitation of the resin sealant is the difficulty of handling it in a moist environment. Even when stringent moisture control procedures are attempted during clinical sealant application, contamination can occur, and these contaminations are the likely cause of the sealant failure.[12] Saliva contamination of etched enamel surface before sealant placement was cited as the most common reason for sealant failure.

Resin-based and glass ionomer-based pit and fissure sealants are commonly used. In this study with these sealants, we also used newly introduced self-adhering flowable composite as a pit and fissure sealant.

In this study, the result showed a reduction in microleakage when using self-adhering flowable composite compared to other sealant materials.

Helioseal F; Composite-based sealant has been studied as a pit and fissure sealant and found to be effective in comparison with glass ionomer-based pit and fissure sealants.[2] It bonds micro mechanically to the tooth structure and has shown a good retention rate. In this in-vitro study, the mean value of the Helioseal F group is 0.5 which is in accordance with Keyur Joshi *et al* study.[13]

Ionoseal, light-curing glass ionomer sealant showed significantly greater microleakage than the other groups.[6] The mean value of Ionoseal is 0.7 which is in accordance with a study done by Effat Khodadadi *et al*.[14]

Dyad Flow; Self-adhering flowable composite, which is a relatively new material introduced by Kerr, USA was evaluated as a sealant. Dyad Flow has GPDM (Glycerol Phosphate Dimethacrylate) adhesive monomer, as per Technical Bulletin Kerr/35104 (2010). It has an acidic phosphate group and two methacrylates, functional groups, for copolymerization with other methacrylate monomers to provide increased crosslinking density and enhanced mechanical strength for the polymerized adhesive.[12] This phosphate functional group creates a chemical bond with the calcium ions of the tooth. Glycerol Phosphate Dimethacrylate monomers ensure a tenacious bond to both enamel and dentin, evidenced by the strength known to all generations of the OptiBond adhesive family. On other hand, the acidic phosphate group for etching the tooth structure and also for chemically bonding to the calcium ions within the tooth structure. These properties are probably responsible for samples showing absolutely no dye penetration (microleakage score: 0) with self-adhesive flowable composite. In this present study in the self-adhering composite group, 100% of specimens demonstrated a score of 0. P Popli Harsha *et al* found in their study 85% of specimens demonstrated a score of 0 in the self-adhering composite group.[7]

Dyad Flow consists of four filler types: a prepolymerized filler, a 1- micron barium glass filler, nanosized colloidal silica, and a nanosized Ytterbium fluoride. The average particle size of Dyad Flow is 1 micron. The handling characteristics of the material are enhanced by the pre-polymerized filler (PPF), making it smooth and easy to manipulate, and allowing better flow along with pits and fissures thus preventing microleakage.[12,15]

In the present study, the resin-based sealant and self-adhering flowable composite and light-curing glass ionomer sealant were compared only with respect to marginal leakage.

However, to study the effectiveness of a sealant, other parameters such as long-term retention, shear bond strength, and its integrity must be considered when comparing the materials. Despite its limitations, this study provides some data to support further research into the use of Dyad flow as a pit and fissure sealant in dentistry.

## CONCLUSION

- In this in-vitro study, microleakage scores of composite-based sealant and self-adhering flowable composite were found to be similar.
- Both the materials performed similarly when used as a pit and fissure sealant in terms of bonding to the tooth structure.
- Self-adhering flowable composite which is a relatively newly introduced composite could be used in place of the composite-based pit and fissure sealants with a reduced number of steps during placement.
- Further research with larger sample size and retention rate in in-vivo studies need to be carried out to confirm the efficacy of self-adhering flowable composite as a pit and fissure sealant.

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