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Comparative Evaluation of Marginal Microleakage of Conventional Fissure Sealants and Self-adhering Flowable Composites as Fissure Sealant in Permanent Teeth - An *In Vitro* Study

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Abstract

Background: Sealant therapy is the safe and effective way to prevent dental caries in newly erupted teeth. Success of sealant therapy depends on the good isolation, patient corporation and the decrease step for the application of sealant.

Aim: Comparative evaluation of marginal microleakage of conventional fissure sealants and self-adhering flowable composites as fissure sealant in permanent teeth-an *in vitro* study.

Materials and Methods: This *in vitro*, an experimental study was conducted on 40 extracted human premolar teeth. The teeth were divided randomly into two groups of 20. In the first group, fissure sealant (Fissurit F, Voco) was placed on the teeth. In the second group, self-adhering flowable composite (Dyad Flow, Kerr, USA) was applied as the sealant. Then, both groups were immersed in 2% fuchsin dye solution for 24 h. Sectioned samples were observed with a stereomicroscope for the extent of dye penetration. Data were analyzed using Mann–Whitney test ($P < 0.05$).

Result: Microleakage in the fissure sealant group was significantly higher than that in the self-adhering flowable composite group.

Conclusion: Microleakage was less using self-adhering flowable composite compared to conventional fissure sealant; therefore, self-adhering flowable composite can be used as a suitable fissure sealant in permanent teeth.

Key words: Dyad flow, Fissurit F, Microleakage, Pit and fissure sealant, Self-adhering composite

INTRODUCTION

Prevention is better than cure, is the rule of the day and as pedodontist we play an important role in providing preventive measures, to the most commonly occurring and tormenting dental disease that is dental caries.

In general, research has demonstrated that carries on occlusal and buccal/lingual surfaces account for almost 90% of caries experienced in children and adolescents. The caries process in the first and second molars usually starts soon after eruption. The occlusal surfaces of teeth, especially molars have complicated morphology with many grooves (fissures) and pits on the occlusal surface and on the buccal and palatal surfaces. These molar teeth are considered the most susceptible teeth to dental caries due to the anatomy of the chewing surfaces of these teeth, which unfortunately inhibits protection from saliva and fluoride and instead favors plaque accumulation. Although fluorides are highly effective in the prevention of caries on smooth surfaces, they are not equally effective in protecting the occlusal surfaces of young permanent molars which are the main pillar of occlusion in the oral cavity.[1] Thus, to reduce the burden of dental disease both in children and adolescent in more preventive way, many researchers and development in restorative materials and techniques were

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done and an idea was developed to preserve natural enamel and dentin which are still the best "dental materials" in existence,[2] by forming a barrier between tooth surface and oral environment, the accumulation of bacteria and food. This leads to the invention of pit and fissure sealants which are the major cornerstone of modern preventive dentistry.[3]

By Simonsen, pit and fissure sealants are used to describe a material that is introduced into the occlusal pits and fissures of caries susceptible teeth, thus forming a micromechanically-bonded protective layer, cutting access of caries-producing bacteria from their source of nutrients.[4]

The idea of obliteration of the fissures to prevent caries was given by Arthur in 1987 and thus following his idea the journey of development of pit and fissure sealant started with the use of varies materials and techniques such as blocking off the susceptible fissures with zinc phosphate cement, mechanical fissure eradication, prophylactic odontotomy, and chemical treatment with silver nitrate. Ingenuity in this effort against fissure caries continues, with new materials and technologies being tested each year. When Buonocore in 1955 described acid etch bonding to enamel as a new technology, it was employed in the form of resin sealants for the first time in the prevention of pit and fissure caries.[5]

A variety of factors plays an important role in the success and failure of sealant therapy such as microleakage at the sealant/tooth interface, wear, and abrasion resistance, the expertise of the clinician and most important is the cooperation of the patient.[3]

In pediatric dentistry, maintaining isolation is the most difficult task to perform during the process of sealant therapy as due to lack of cooperation of the pediatric patient. Thus, inadequate isolation increases the risk of microleakage and subsequent treatment failure. Therefore, use of bonding agents such as self-etching and self-adhering systems has become popular due to the easier application and fewer working steps.[6]

Dye penetration is a widely used technique, which is inexpensive and non-toxic and detects even small amounts of leakage.[7] This study aimed to compare the microleakage of self-adhering flowable composite and conventional fissure sealant.

MATERIALS AND METHODS

This study is a non-randomized comparative *in vitro* study. The study was conducted in the Department of Pediatric and Preventive Dentistry, and Department of Oral Pathology and Microbiology, at Vokkaligara Sangha Dental College and amp; Hospital, Bengaluru. Institutional Ethical Committee Clearance was obtained for the study. The samples consisted of 40 healthy premolar teeth without caries, restorations, cracks, or defects were extracted due to orthodontic reasons and randomly divided into two groups of 20. After collection, all the soft tissue, debris, calculus, and plaque were removed from the teeth with periodontal scaler and curette. The cleaned teeth were then stored in distilled water.

Cleaning of Occlusal Surfaces

Occlusal surfaces of the teeth were given a prophylaxis with water based on slurry of pumice, using a short bristle brush. Teeth were then washed thoroughly with water spray. A sharp explorer tip was passed through all pits and fissures to remove pumice (remaining if any).

About 40 premolars selected for the study were assigned to two groups, A and B by simple random sampling, with each group consisting of 20 teeth. Fissurit F (Voco, Germany) was applied to teeth in Group 1, and Dyad Flow (Kerr, Sybron Dental Specialties, USA) was applied to teeth in Group 2, as pit and fissure sealants, according to the manufacturers' instructions.

Placement of Sealant

Group 1

The occlusal enamel surface of all specimens was etched using 37% phosphoric acid for 15 s, and then etched surface was rinsed and air-dried for 10 s. Bonding agent (One Coat Bond SL, Coltene) was applied on the occlusal fissures of previously etched surface (37% phosphoric acid) for 15 s using a microbrush. The occlusal surface of teeth was air-dried for 5 s to evaporate the solvent and light cured for 20 s using light curing unit (Coltolux LED). Fissurit F sealant was then applied on the fissure and cured for 20 s according to manufacturer's instructions.

Group 2

According to the manufacturer's instructions, self-adhering flowable composite (Vertise Flow, Kerr, USA) does not require any acid etching or bonding protocol before the application. Self-adhering flowable composite was placed on the grooves using a microbrush for 20 s. Light curing was performed using Coltolux light-curing unit for 20 s.

Procedure for Microleakage Testing

The teeth were thermocycled at 5°C and 55°C, with a dwell time of 30 s; the specimens were subjected to 500 such cycles.

To test the microleakage, dye penetration technique was used. Before placing the teeth in dye solution, all the surfaces of the teeth were coated with two layers of nail varnish except for 1 mm around the sealant. A different color nail varnish was used for each group for easy distinguishing.

All the groups were then immersed in 2% fuschin solution for 24 h. The samples were removed and gently rinsed to remove excess dye.

Each tooth was sectioned longitudinally in a mesiodistal direction through the center of the sealant using high-speed handpiece with a diamond disc of 0.02 mm in thickness. The root portion of the specimens was sectioned and removed.

The sectioned specimens were then analyzed at ×40 magnification under a stereomicroscope for dye penetration and scored using score rank scale.

A rank scale used to score dye penetration (Figure 1):[6]

(0) : No dye penetration
(1) : Dye penetration limited to the outer half of the sealant
(2) : Leakage up to the inner half of the sealant
(3) : Dye penetration extending to the underlying fissure.

The tooth-sealant interface was photographed using a digital camera attached to the microscope.[1]

- Data were then analyzed by Mann–Whitney tests at a significance level of $P < 0.05$.

RESULTS

In the self-adhering composite group, 85% of specimens demonstrated score 0% and 10% showed Score 1 of dye penetration. In conventional fissure sealant group, 45%, 25%, 20%, and 10% of specimens demonstrated Score 0, Score 1, Score 2, and Score 3 of dye penetration, respectively (Table 1 and Graph 1). According to the Mann–Whitney *U*-test, microleakage was found to be significantly less in the self-adhering group when compared to the conventional fissure sealant group.

Higher mean score was recorded in Fissurit F group compared to self-adhesive flowable composite group, and the difference between them was found to be statistically significant ($P < 0.05$) (Table 2).

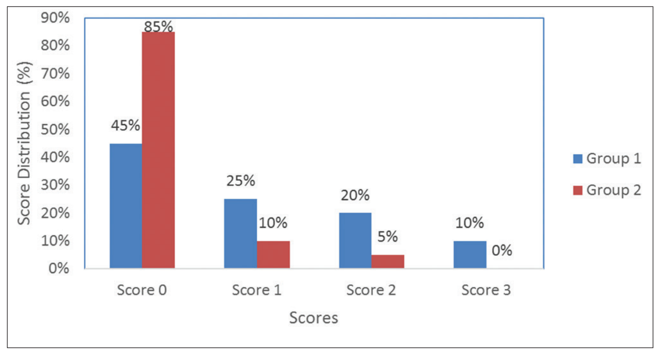
Table 1: Distribution of scores

Score	n (%)	
	Group 1	Group 2
Score 0	9 (45)	17 (85)
Score 1	5 (25)	2 (10)
Score 2	4 (20)	1 (5)
Score 3	2 (10)	0 (0)
Total	20 (100)	20 (100)

Table 2: Mean score

Group	n	Mean±SD	SEM	Mean difference	Z	P value
Fissurit F	20	0.95±1.05	0.23	0.750	−2.697	0.007*
Self-adhesive flowable composite	20	0.20±0.52	0.12			

*Denotes significant difference. SD: Standard deviation, SEM: Standard error of mean



Graph 1: Distribution of scores

DISCUSSION

This comparative study was conducted to evaluate the marginal microleakage of conventional fissure sealant and self-adhering flowable composite in permanent teeth. A reduction in microleakage was noted when using self-adhering flowable composite compared to fissure sealant material.

Microleakage is a significant problem in operative dentistry and can lead to secondary caries, pulpal injuries, post-operative tooth hypersensitivity, marginal discoloration, and fracture of restorations.

Bond strength and marginal leakage of restorative materials are usually investigated *in vitro*. A perfect restorative material should provide high bond strength and minimal leakage.

Marginal seal is important for the success of sealants because penetration of microorganisms beneath the sealants initiates carious lesions.[6]

Ganesh and Shobha 2007 believe that the primary factor affecting the performance and durability of a sealant is its marginal adaptation to the enamel, which provides a good seal and minimizes microleakage.

One solution is to use adhesives or self-etching sealants, which do not need rinsing and thus, decrease the risk of contamination.[8]

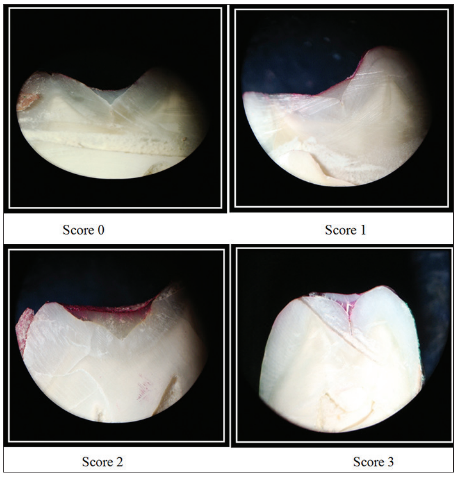


Figure 1: The tooth sections photographs showing microleakage under stereomicroscope

Various methods are used to evaluate microleakage *in vitro* such as:

- Chemical markers,
- Radioactive isotopes,
- Penetration of bacteria, neutron activation analysis,
- Scanning electron microscopy,
- Creating artificial caries,
- Electrical conductivity and
- Dye penetration methods.

Dye penetration is a widely used technique, which is inexpensive and non-toxic and detects even small amounts of leakage. In comparison with bacterial penetration, 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, dye penetration method was used in this study to evaluate microleakage.[9,10]

In this study, conventional sealant group showed 45% of Score 0 whereas self-adhesive flowable composite showed 85% of the score.

Furthermore, 10% of Score 3 was seen in conventional sealant whereas in self-adhesive flowable composite showed 0% of Score 3.

Similar results were seen in Imam and Marginal study which shows 20% of Score 0 and 30% of Score 3 in conventional fissure sealant and 76.7% of Score 0 and 0% of Score 3 in the self-adhesive group.[6]

Other studies by Vichi *et al.*, in 2013 on the properties of self-adhering flowable composites, they also found that self-etch and self-adhering flowable composites had lower microleakage than conventional flowable composites.[11]

In contrast, study by Biria *et al.*, in 2011 microleakage of self-etch sealants and conventional sealants were compared *in vitro*. They found that self-etch and self-adhesive sealants had greater microleakage in enamel margin than conventional sealants. They believed that self-adhesive sealants cannot form resin micro-tags and an acceptable hybrid layer in the enamel, which result in microleakage in the long run.[12]

Possible reason for low microleakage in Group 2:

1. One of the possible reasons explaining lower microleakage of self-etch and self-adhesive cements is a higher hygroscopic expansion of these materials and their relatively low polymerization shrinkage.
2. Acidic resins that form following the use of self-etch adhesives absorb more water than natural resins; therefore, greater hygroscopic expansion occurs. In self-etch composites, the hygroscopic expansion compensates for the polymerization shrinkage and provides a better seal. Furthermore, improved sealing of the self-etch composites can be due to the unique polymerization/bonding process.
3. The advantage of using Dyad Flow, like Fissurit F, is that it does not require any bonding agent. According to the Technical Bulletin Kerr/35104 (2010), Dyad Flow has glycerol phosphate dimethacrylate (GPDM) adhesive monomer. It consists of a phosphate functional group that creates a chemical bond with the calcium ions of the tooth. GPDM monomers ensure a tenacious bond to both enamel and dentin, evidenced by the strength known to all generations of the OptiBond adhesive family. A GPDM adhesive monomer acts as a coupling agent. On the one hand, it has an 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 few samples showing absolutely no dye penetration (microleakage Score: 0) with Dyad Flow.[5,13-15]

In this study, use of self-adhering composite resulted in the proper marginal seal and significantly reduced microleakage. This is of particular importance especially in pediatric dentistry and permanent fissure sealant therapy and will decrease recurrent caries in the long run.

Microleakage of other types of cement and self-adhering composites needs to be compared in future studies.

CONCLUSION

By eliminating the rinsing and drying processes and by the use of isolation process alone, self-adhesive composites can be effectively used for sealant therapy not only in patients with difficult saliva control but also in children to save time and decrease technique sensitivity during sealant placement.

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