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SEALING ABILITY OF FLOWABLE RESIN COMPOSITES FISSURE SEALANTS

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ABSTRACT

Background/Aim: Prevention of caries initiation is a common concern for both clinicians and patients, among the effective ways of dental caries prevention is pits and fissures sealing. The current *in vitro* study was performed to assess the sealing ability and microleakage of three commercial flowable composites used for fissure sealing.

Materials and Methods: The microleakage and sealing ability of three flowable resin composites (Filtek Bulk Fill Flowable Restorative, SureFil SDR Flow and Vertise Flow) were evaluated and compared with the sealing ability of conventional composite resin fissure sealant (Helioseal F). 120 extracted caries free premolars were collected and equally distributed into four groups (n=30). Fissure sealant flowable composites were applied according to manufacturer's instruction. Samples were subjected to thermocycling, then immersed in a methylene blue dye for 48 hours. After that, each tooth was sectioned in to three sections and examined by a stereomicroscope with a X15 magnification. Photographs were captured for all sections to show and scored for microleakage as 0, 1, 2 or 3. The collected data was organized and analyzed by Chi-Square test, p value less than 0.05 was considered statistically significant.

Results: There were statistically significant differences between the three flowable composite vs Helioseal (p=0.000). There were statistically significant differences between Filtek Bulk Fill Flowable Restorative vs SureFil SDR Flow and Vertise Flow. Also, there was significant difference between SureFil SDR Flow vs Vertise Flow (p= 0.000 for all comparisons).

Conclusions: The three tested flowable composite showed an acceptable sealing ability and low microleakage compared to Helioseal F sealant, the SureFil SDR Flow had the best sealing ability.

KEYWORDS: Filtek Bulk Fill Flowable Sealant, Microleakage, Self-adhesive Flowable sealant & Stereomicroscope, SureFil SDR Flow.

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INTRODUCTION

Caries is still dental health problem over all the world although development of several preventive methods [1]. Pit and fissure sealants were developed to occlude the retentive areas on the occlusal surface and prevent accumulation of food remnants and cariogenic bacteria and subsequently prevent initiation of dental caries in these areas [2]. Dental sealants are considered successful if they protect the tooth structure by adhering firmly to enamel surface and prevents its direct contact with the oral environment [3]. Many materials were developed to seal enamel fissures; flowable resin composites are low viscosity resin, with lower filler (20-25%) than the conventional restorative resin materials and they have a wide variety of applications, besides being used as fissure sealants [4,5].

Although many developments in the field of adhesives, a gap-free margin is not completely obtained [6-8]. Flowable resin composites introduced to act as shock absorbable and improve adaptation, Self-adhering flowable composite (SAFC) combines the advantages of both adhesive and restorative material technologies [9]. SAFC provides the least possible chair time, allowing fewer steps, providing less chance for errors, and providing shorter treatment sessions for the patient [10]. Clinical evaluations could not prove this idea so far [11,12]. Therefore, the objective of the current laboratory study was to microscopically assess and compare microleakage of three commercially available flowable resin composites after thermocycling and immersion in methylene blue dye by using stereomicroscope.

MATERIALS AND METHODS

The current study was an experimental *in-vitro* study, in which three flowable resin composite materials that are used as restorative and/or fissure sealant materials, were compared with filled resin-based pit and fissure sealant.

Materials:

- Nano-filled flowable composite resin (Filtek Bulk Fill Flowable Restorative; 3M ESPE).
- Bulk- Fill flowable composite resin (SureFil SDR Flow; Dentsply Caulk).
- Self-adhering flowable composite resin (Vertise Flow; Kerr).
- Filled resin-based pit and fissure sealant (Helioseal F; Ivoclar Vivadent).

TABLE (1) Composition of flowable composites and sealant used.

Brand Name	Composition
Helioseal F	**Resin Matrix:** Bis-GMA, urethane dimethacrylate, triethylene glycol dimethacrylate (58.6wt%). **Filler content:** Silicon dioxide and fluorosilicate glass. 40.5% by weight.
Filtek Bulk Fill Flowable Restorative	**Resin Matrix:** BisGMA, BisEMA(6), UDMA. **Filler content:** Zirconia/silica with an average particle size 0.6 microns and ytterbium trifluoride particle size range (1 - 5 microns). Filler loading is 64.5% by weight.
SureFil SDR Flow	**Resin Matrix:** Ethoxylated Bisphenol A dimethacrylate (EBPADMA); Triethyleneglycol dimethacrylate (TEGDMA); Modified urethane dimethacrylate resin. **Filler content:** Barium-alumino-fluoro borosilicate glass and strontium alumino-fluoro-silicate glass. 68% by weight.
Vertise Flow	**Resin Matrix**: Glycerol phosphate dimethacrylate (GPDM). **Filler content:** Prepolymerized filler, 1-μm barium glass, nano-sized colloidal silica and ytterbium fluoride. 70% by weight.

One hundred and twenty caries free recently extracted human maxillary and mandibular premolars extracted due to orthodontic reasons were used in an *in vitro* experimental study. The pit and fissures of teeth were cleaned with low-speed handpiece brushes and fluoride free polishing paste. Teeth were distributed randomly into four equal groups of thirty teeth each. Each group received a different pit and fissure material sealant. Group I which was used as control (Helioseal F), Group II (Filte Bulk Fill Flowable Restorative), Group III (SureFil SDR Flow) and Group IV (Vertise Flow).

Fissure Sealant Application

All materials were used according to manufacturer's instructions and only one operator performed all the procedures of specimen's preparations.

Microleakage Assessment

The sealed teeth were soaked in a solution of artificial saliva (NeutraSal^{R}, Bausch Health Companies Inc. NSL.0021.USA.19) inside plastic containers for a period of one week. The containers were stored in an incubator at temperature of 37°C, in order to simulate the oral conditions, the teeth were then thermocycled at 5±2°C to 55±2°C for 500 times, with a dwell time for thirty seconds before testing.

Each tooth apex was sealed with a sticky wax and double coated with a nail polish, except for 1 mm a distance surrounding the sealant. The sealed teeth were kept immersed in 5% methylene blue for 48 hours, then rinsed with tap water. After that, teeth were sectioned in bucco-lingual direction in the middle of their proximal surfaces with a low-speed Isomet saw (TECHCUT 4TM\Rancho Dominguez, California).

Each tooth sectioned into three sections for assessment of dye penetration by means of stereomicroscope (Meiji Techno\ San Jose, California) at x15 magnification. The sectioned specimens were photographed and scored for microleakage dye penetration. The photographs were examined and scored by a one observer and then the scores were confirmed by another observer for confirmation. The evaluation of microleakage depended on the criteria described by Cooley et al., [13] as the follows:

Score 0: No dye penetration.

Score 1: Dye penetration was restricted to the outer half of the sealant.

Score 2: Dye penetration reached the inner half of the sealant.

Score 3: Dye penetration extended to the underlying fissure.

Statistical Analysis

The collected data was analyzed using SPSS for Windows (version 22, IBM, Corp., Chicago, IL, USA). The Chi-square test was used to compare the frequency of microleakage scores among the four groups and between each two groups. P value ≤ 0.05 was considered statistically significant.

RESULTS

The results revealed a high statistically significant differences among the tested materials (p=0.000). There were statistically significant differences between Group I vs Group II, III and IV. Also, there were a significant inter-group differences between Group II vs Group III and IV as well as between Group III vs Group IV (p=0.000 for all comparisons) (Table 2 and figure 1).

TABLE (2) The number of microleakage scores among different sealant materials

Microleakage scores	Group 1 No. *@$	Group 2 No. *&R	Group 3 No. @&H	Group 4 No. $RH	P
0	42	68	78	64	0.000
1	33	14	12	16	
2	12	8	0	8	
3	3	0	0	2	
Total	90	90	90	90	

Group I = positive control (Helioseal F), Group II = Filte Bulk Fill Flowable Restorative, Group III = SureFil SDR Flow, Group IV = Vertise Flow. No = Number, p = p value calculated by Chi square test, *,@,$,&,H,R= similar symbols means significant differences in corresponding columns.

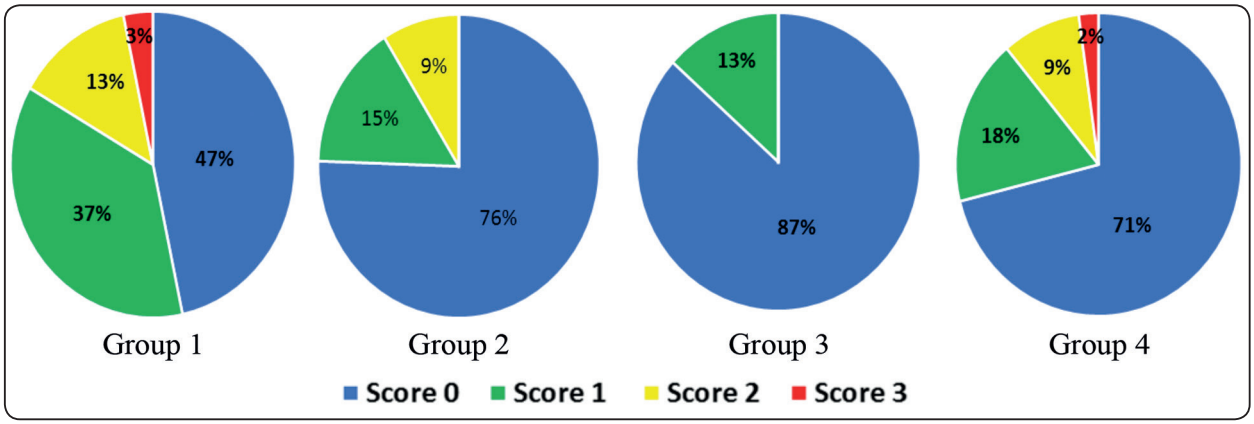

Fig. (1) Pie charts showing the percentage of different microleakage scores

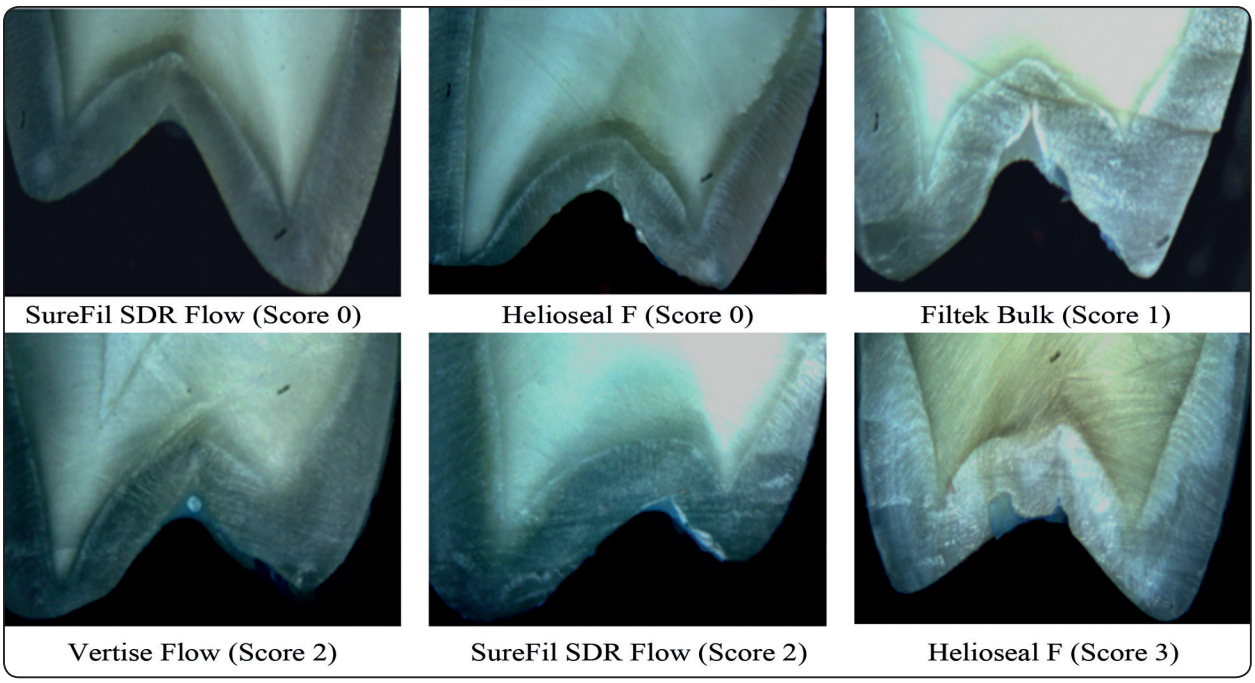

Fig. (2) Steriomicroscope photographs of different sealants materials and leakage scores

DISCUSSION

There is rapid improvement as well as development of both sealant materials and application techniques in order to reduce microleakage and subsequent treatment failure. In the present *in vitro* study; microleakage of three commercial flowable composite materials used as restorative and/or pit and fissure sealants were evaluated, in relation to a conventional and frequently evaluated fissure sealant (Helioseal F). Helioseal F was used as a control reference in the present study as previously done in many *in vitro* studies which reported it to show better sealing ability compared to un-filled resins and glass ionomer, when used as a pit and fissure sealants [14, 15].

All the sealants used under the current study were applied without enameloplasty to preserve the integrity of enamel and observe their behavior without any removal or modification of tooth structure. The sealed teeth were thermocycled for simulating the thermal changes of oral cavity environment, to which the sealed teeth could be subjected during their functioning by eating and drinking under normal *in vivo* conditions.

Dye penetration was employed in the study because it is easier than the bacterial penetration and the incorporation of their metabolites. Besides, the accumulation of protein components on any marginal gap at the tooth-sealant interface might improve the sealing and hence, the microleakage results could be overestimated with *in vitro* testing, compared to its clinical performance in the oral cavity [16,17].

The results of the present study showed significantly less microleakage of the three examined flowable sealants compared to Helioseal F. SureFil SDR Flow material was found to be significantly better in sealing ability compared to Filtek Bulk and Vertise Fil materials (Table 2 and figure 1). The better sealing ability of SureFil SDR Flow may be due to its characterization by Stress Decreasing Resin (SDR) technology through its urethane dimethacrylate structure that assumed to allow better reaction compared to the typical methacrylate systems used in almost all current composite resin restorative materials. This new technology is said to reduce the polymerization shrinkage and subsequently the resulting stress, as it utilizes the SDR resin with larger size compared to conventional resin and chemical incorporation of a polymerization modulator which embedded in the core of the polymerizable SDR resin monomer [18].

Although the application of phosphoric acid etching could magnificently enhance the bond between enamel and the fissure sealant material, its use could present some clinical difficulties because of its unacceptable taste and more time-consuming application procedures. So that, recently self-etching flowable composites were introduced, as Vertise Flow, for avoiding the use of acid etching. It gave a significantly better result compared to Helioseal F, On the other hand, its sealing ability as indicated by its microleakage scores was significantly worse than SureFil SDR Flow and Filtek Bulk (Figure 2). This finding can be attributed to its different fillers in composition, as well as, Vertise Flow which is a self-etching flowable composite and applied without needing a separate preliminary acid etching step, which might compromise its bonding effectiveness [19].

The results of the present study showed a significantly higher sealing ability of SureFil SDR Flow and Filtek Bulk Fil flowable composite sealants than the conventional fissure sealant (Helioseal F), which could be explained by its high flowability; allowing their improved resin penetration into the morphologically porous enamel created by the application of acid etching prior to their application. These results were agreed with the results obtained by Gillet et al. [20] as they concluded that, using a flowable composite is a superior technique for

sealing of caries-free deep fissures. Also, the current results support the results obtained by Arastoo et al [21] where they reported that, flowable composite (Heliomolar Flow, Filtek Z350) had almost no microleakage compared to Filled (Helioseal F) and Unfilled resin based (Clinpro) sealants.

The present results disagreed with that obtained by Kwon and Park [22] who found that the microleakage of flowable composites (Filtek Flow, Tetric Flow, Charmfil Flow) was higher compared to the filled sealant (Ultraseal XT Plus), this disagreement may be due to the differences in methodology and materials used.

Within the limitations of the current experimental study, the present results may be viewed as the theoretical level of microleakage of the tested materials which may be reflect their sealing ability in oral environment. Thus, these results may be accepted as an aid for selecting the best sealant materials of a good sealing ability before placement of a pit and fissure sealants in clinical practice.

CONCLUSIONS

From the current study, it could be indicated that:

1- All tested sealants failed to achieve complete leakage-free conditions.

2- All tested flowable composite materials, Filtek Bulk, SureFil SDR Flow and Vertise Flow, have a good sealing ability compared to the conventional fissure sealant (Helioseal F).

3- SureFil SDR Flow showed the least microleakage among the tested materials.

RECOMMENDATIONS

Further *in vivo* studies are required for clinical evaluation of the efficiency and durability of these flowable composites when used as sealant materials.

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