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COMPARATIVE EVALUATION OF THE IMPACT OF INVASIVE AND NON-INVASIVE TECHNIQUES ON MICROLEAKAGE OF TWO PIT AND FISSURE SEALANTS

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ABSTRACT

Objective: The current study aims to compare the impact of invasive and non-invasive techniques on the microleakage of two fissure and pit sealants. **Materials and methods:** The study included 84 first permanent molar teeth. Teeth were sorted into two groups (n=42) based on the sort of fissure sealant utilized: A1 was sealed with resin fissure sealant (helioseal F), and A2 was sealed with flowable composite fissure sealant (tetric flow). According to the fissure sealant preparation technique, each group was divided into two subgroups (n=21): B1 represents an invasive technique, and B2 represents a non-invasive technique (intact). Each subgroup was furtherly divided according to storage times into three classes (n=7): C1 (one week), C2 (one month), and C3 (three months). Teeth were thermocycled and stored. Then, Microleakage was investigated by immersing the teeth in a 5% methylene blue dye. **Results:** Gr-A2 recorded a higher leakage score mean value than the Gr_A1 group. The difference was statistically significant ($p< 0.05$). The Gr B1 group was observed to have a lower mean leakage score than the Gr B2 group ($p< 0.05$). The highest leakage score mean values were recorded after three months of storage followed by one-month storage, while the lowest leakage score mean values were recorded after one-week storage ($p < 0.05$). **Conclusion:** The used sealants failed to achieve completely leak-free conditions. Helioseal F sealant had the least amount of microleakage. Moreover, invasive techniques provide better marginal sealing. The least microleakage was recorded at one week, while the highest was three months.

KEY WORDS: Microleakage, Helioseal F, Tetric flow, Thermocycling, Methylene blue dye.

INTRODUCTION

Dental caries is a carbohydrate-modified local infection that destroys the tooth's hard tissues[(1)]. Because of their morphological complexity, occlusal surfaces are particularly susceptible to caries formation, favoring complex fluoride exposure and plaque accumulation[(2)]. 90% of caries lesions start in the fissures and pits on the occlusal surfaces of permanent molars[(3)]. Fissure and pit sealants represent one preventive option for imperfections in the enamel, such as fissures and pits[(4)]. Sealants on the first permanent molar have been found to reduce the need for additional restorations and prevent dental caries' development[(5)]. However, the presence of sealants influences the performance of conventional methods in detecting occlusal caries and monitoring their progression. Thus, adjunct methods must be used to improve monitoring assessments and increase diagnostic accuracy[(6)].

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Some of these methods are based on the fluorescence, which is emitted by the porphyrins present in caries lesions, when stimulated at specific excitation wavelengths[7,8]. Two laser fluorescence devices, DIAGNOdent 2095 (LF; KaVo, Biberach, Germany) and DIAGNOdent 2190 (LFpen; KaVo, Biberach, Germany), have been currently used as an adjunct in caries detection [9,10].

A healthy tooth structure exhibits little or no fluorescence, while a carious tooth structure shows fluorescence proportional to the amount of decay[11]. Cleaning the occlusal surface with pumice prophylaxis before sealant placement, air polishing, air abrasion, and an invasive technique (mechanical preparation of fissures) can all help to improve sealant retention[12]. The only usage of acid etching for preparing the enamel prior to sealant placement leads to some microleakage[13].

Another significant element for effective sealant is marginal integrity, identified by measuring microleakage. Accessing bacteria and oral fluids to the area between the restorative material and tooth is known as microleakage[14]. Microleakage can occur due to a lack of sealing, leading to caries progression beneath the restoration. Over three months, the current investigation intended to evaluate and compare the impacts of non-invasive and invasive preparation on Helioseal F and tetric flow microleakage.

MATERIALS AND METHODS

Study setting: The research involved 84 first premolar teeth in optimum condition when extracted for orthodontic reasons by the Oral and Maxillofacial Surgery clinic, Cairo boys, Faculty of Dental Medicine, Al-Azhar University.

Study design: The study was carried out on 84 extracted first premolar teeth.

Sample examination and preparation: Visual examination was performed using a magnifying Amtech loup light 5x. Teeth were scaled and then submerged for 24 hours in a 0.1% thymol solution before being preserved in distilled water that was changed daily. **Sample Grouping:** According to the type of fissure sealants, 84 teeth were divided into two groups (A) (n=42) (A1 Helioseal F and A2 Tetric N flow). According to the preparation processes, each of the previous groups was separated into two subgroups (B) (n=21) (B1 invasive and B2 non-invasive). Then, each subgroup was classified into three classes(**C**) (n=7), according to the storage time (**C1**1week, **C2** 1month, and**C3** 3months).

Intervention: Fissurotomy bur (18SS White, Ivoclar North America, Inc.) was used for the invasive preparation in a gentle sweeping motion. The depth of penetration was confined to the enamel. In the non-invasive preparation procedure, pits and fissures were kept intact. Both sealants were applied as directed by the manufacturer.

Thermocycling: Before being tested, the teeth were thermocycled 500 times at 5±2°C to 55±2°C with a 30 seconds dwell time.

Storage of samples: The sealed teeth were kept in plastic containers with artificial saliva replaced daily.

Preparation of samples for microleakage: The following steps were conducted to prepare all samples for immersion in dye solution: Except for 1 mm surrounding the sealant, each tooth apex was sealed with sticky wax and double-coated with nail polish. Therefore, microleakage from regions other than the fissure sealant margin was prevented.

Microleakage Assessment: After the nail polish had dried completely, each group's teeth were immersed for 24 hours in 2% methylene blue dye (Supreme Organization for Drugs, Germany) and incubated at 37°C. Then, a scalpel was used to clear the nail polish to be cut easily. For sectioning, the samples were put on a specific holding device. To avoid thermal damage, the teeth were divided into two portions in a buccolingual direction along the longitudinal axis using a low-speed diamond saw (Top Dent, Edenta Golden, Swiss) under water spray. A USB digital microscope (U500X

Digital Microscope, Guangdong, China) was used to measure the dye penetration along with the restoration-tooth interface at 35x magnification.

The dye penetration scale established by Verbö & Raadal[15] was used to assess microleakage at the tooth/sealant interface.

0: Dye penetration is non-existent.

1: Dye penetration is limited to the sealant's outer half.

2: Dye penetration is into the sealant's inner half.

3: Dye penetration is into the underlying fissure.

Statistical analysis

The data were presented as a mean and standard deviation (SD). Graph Pad inStat (Graph Pad, Inc.) software for Windows was used to evaluate the results. P<0.05 was considered statistically significant. To compare data, the Mann-Whitney and Kruskal-Wallis tests were utilized. To investigate the effect of each variable (material, technique, and time), a three-way ANOVA was used.

RESULTS

Regardless of preparation technique or time, the Gr A1 group was observed to have a lower mean leakage score than the Gr A2 group. A statistically significant difference in microleakage scores between the groups (p<0.05) was determined by Three-way ANOVA and pair-wise Tukey's post hoc tests, as shown in Table 1.

TABLE (1) Comparison of total microleakage scores mean values as a function of the material type.

Variables		*Mean* ± SD	*Statistics*
Material type	*Gr_A1*	1.028^{B}±0.33	*P-value*
	Gr_A2	1.94^{A}±0.43	<0.0001*

Different letters indicate significance (p<0.05)
*ns; non-significant (p>0.05) *; significant (p<0.05)*

The Gr B1 group demonstrated a lower mean leakage score than the Gr B2 group. The difference in microleakage values between the two techniques was significant, according to three-way ANOVA and pair-wiseTukey'sposthoctests(p<0.05)(Table2).

TABLE (2) Comparison of total microleakage scores mean values as a function of the preparation technique.

Variables		**One week (a)**	**Statistics**
Preparation technique	Gr_B1	1.19^{B}±0.42	P-value
	Gr_B2	1.78^{A}±0.33	<0.0001*

Different letters indicatce significance (p< 0.05)
*ns; non-significant (p> 0.05) *; significant (p< 0.05)*

Regardless of the material or technique, it was found that the highest leakage score of mean values was recorded after three months of storage, followed by one month of storage. In contrast, the lowest leakage score of mean values was recorded after one week of storage. According to the three-way ANOVA, the difference in microleakage scores between different storage times was statistically significant, p< 0.05 (Table 3).

TABLE (3) Comparison of total microleakage score mean values as a function of the storage time.

Variable	*Evaluation time*			Statistics
	One week	*One month*	*Three months*	*P*-value
Mean±SD	0.83^{C}±0.58	1.54^{B}±0.48	2.08^{A}±0.5	<0.0001*

Different letters indicate significance (p<0.05)
*ns; non-significant (p>0.05) *; significant (p<0.05)*

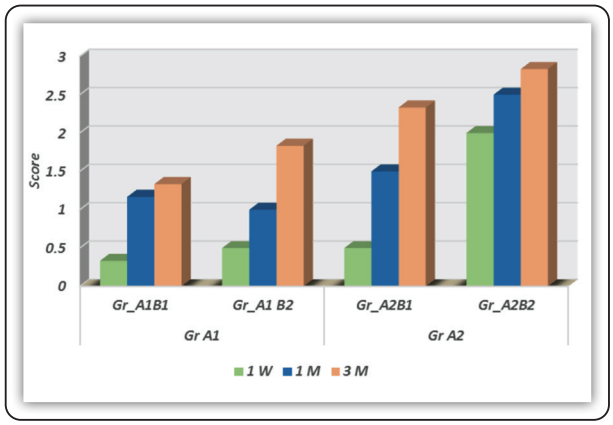

FIG (1) Column chart of leakage scores means values for both groups as a function of preparation technique and evaluation time

FIG (2) Score 0: Helioseal F

FIG (3) Score 3: Tetric Flow

DISCUSSION

Fissure sealants prevent plaque microflora and food-borne debris accumulation in caries-susceptible pits and fissures. Choosing the best sealing procedure has been the subject of several investigations. Muller-Bolla et al.[16] found insufficient evidence to determine the optimal pit and fissure sealing strategy. To increase their efficiency, invasive sealing techniques (enameloplasty) have been introduced[17].

The fissurotomy bur tapered shape, and small size were created mainly to enlarge deep pits and fissures. This step has the impact of eliminating patient discomfort and eliminating the requirement for local anesthesia [18].

After enameloplasty, the tooth should be acidly etched to generate microporosities in which the sealant can enter and form resin tags. To preserve the integrity of enamel and observe their activity without removing or modifying tooth structure, the sealants employed in this study were administered without enameloplasty. All the sealed teeth were thermocycled for simulating the thermal changes of the oral cavity environment[19]. The temperature range in this investigation was 5°C to 55°C, which was the most clinically relevant as reported by Penugonda et al.,[20] and Styner D et al. [21]

Because artificial saliva does not affect the protein and enamel structure, it was used as a storage solution for the extracted teeth[22]. Dye penetration was employed in the study because it was easier than bacterial penetration and the incorporation of their metabolites.

Compared to flowable composite Gr A2, Gr A1 filled resin-based pit, and fissure sealant (Helioseal F) demonstrated less microleakage than group GrA2. This could be due to the Helioseal F fissure sealant's lower filler loading of 40.5% compared to 63% of Tetric Flow. The lower filler content of Helioseal F contributed to lower viscosity and easier flowability and penetration in to the complicated pit and fissure

system. These findings were supported by Salama FS et al., [12]. Previous research by Singh, S., et al., [23], Francescut P, Lussi A.,[24] and Kwon HB, Park KT[25] were consistent with these findings. These results disagreed with the previous study obtained by Gillet et al.,[26] Arastoo S et al., [27] El-Bouhi. M.Y, El-kwatehy M. AW et al.,[19] and Panse, A.M., et al.,[28]. Gillet et al., found that utilizing a flowable composite for sealing caries-free deep fissures was a superior technique. In comparison to filled and unfilled resin-based sealants, flowable composite showed nearly no microleakage[26]. According to Arastoo S et al.,[27] and El-Bouhi. M.Y, El-kwatehy M. AW et al., concluded that flowable resin composite showed little microleakage compared to Helioseal F. Panse, A.M., et al.,[28] concluded a higher tolerance of the flowable composite sealant to microleakage and better bond strength than the conventional pit, fissure sealant

Gr_B1 (invasive) presented a significantly lower leakage score mean value ($p < 0.05$) than *Gr_B2*(non-invasive), as invasive pit and fissure sealing method has been introduced in order to do straightforward cleaning or to increase the penetration effect of sealant into the pit or enamel rods[29-31]. Derelioglu S.S et al., [32] supports these findings., Haznedaroglu E. et al. [33], and Hatirli, H. et al[34]. Others, such as Balaprasannakumar et al. [35], did not find a significant difference in the success rates of enameloplasty sealant technique (EST) and conventional sealant technique (CST), and that both CST and EST produced favorable outcomes. Alternatively, [36, 37] disagreed and argued their benefits.

The difference in the microleakage scores between different storage times was statistically significant; one-week storage recorded the lowest leakage score mean value followed by one-month storage, then the highest leakage score mean value was after three months. The solubility of adhesive compounds and their ability to absorb water are crucial elements in influencing a restoration's lifespan and marginal integrity. Water has a crucial role in the chemical decomposition of polymer molecules, which was agreed by Marcela R O Carrilho et al., [38], Z C Cehreli et al.,[39], and A Gwinnett et al. [40]. Long-term water storage is enhanced the degree of microleakage under fissure sealants, according to Z C Cehreli et al.,[39]. According to Gwinnett, A et al.,[40] the effect of water storage on the embrittlement (plasticization) of resin-based biomaterials and the disintegration of resin tooth bonding was well recognized.

CONCLUSION

Based on the findings of this study, it could be concluded that both the sealants used in the study failed to achieve complete leakage-free conditions. Helioseal F sealant showed less leakage compared to flowable composite and could be a superior material in daily clinical practices.

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