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Effect of Three Different Moisture Contamination Conditions on the Marginal Sealing Ability of Two Commercially Available Fluoride-Releasing Pit and Fissure Sealants

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ABSTRACT

Introduction: Sealants used in pediatric dentistry provide a mechanical barrier in the anatomical pits and fissures thus, preventing dental decay.

Aim: To compare the effectiveness of a glass ionomer and a resin-based fissure sealing material under four different contamination conditions.

Materials and Methods: An in vitro study was carried out using 120 extracted mandibular molars which were randomly divided into 2 groups of 60 each, to be sealed with Glass ionomer sealant (GC Fuji Triage) and resin-based sealant (Clinpro™, 3M ESPE) respectively. The groups were further divided into 4 subgroups depending upon the contamination condition. The four different conditions were control (no contamination), water contamination, saliva contamination and saliva contamination followed by air drying. Sealant placement was done after respective contamination protocols and the teeth were further subjected to conditions simulating the oral environment. Each tooth was cut longitudinally into 3 sections which were examined under a stereomicroscope and analysed using UTHSCA image tool program. The findings were tabulated and subjected to statistical analysis.

Results: The results revealed a significant difference between the sealant groups in the salivary contamination subgroup (p= 0.039). Intragroup comparisons in both Glass ionomer (p = 0.000) and Clinpro (p = 0.005) groups revealed significant difference within the four subgroups. Highest microleakage scores were obtained with the saliva-air drying condition for both the sealant groups.

Conclusion: Salivary contamination followed by air drying leads to maximum microleakage in both the type of sealants. Clinpro performed better than Fuji VII under both contaminated and uncontaminated conditions.

Key Words: Pit and fissure sealants, Microleakage, Contamination, Fluoride releasing, Dental Caries

INTRODUCTION

The worldwide increase in the prevalence of dental diseases is a constant reminder of the almost universal need for effective dental health.[1] Child and young adults are the ones who are majorly affected with dental caries, may face health consequences if left untreated.[2] Paediatric dental profession is constantly searching for newer dental materials that help make the overall dental experience for children more pleasant and efficient. Dental caries in children is mainly seen on pits and grooves on the tooth surfaces.[3] These occlusal pits and fissures comprise of different morphologies that are complex and difficult to cleanse creating a focus for food remnants and microorganisms. One of the materials widely used in paediatric dentistry is the pit and fissure sealants which are advised as a part of a comprehensive approach in the prevention of dental decay. Sealants provide a mechanical barrier to food debris thus to caries

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causing microorganisms in the anatomical pits and fissures thereby halting incipient lesions and preventing cavitation.[4]

Currently, sealants are classified based on composition as glass ionomer based or resin-based. Glass ionomer sealants are measured to have several benefits as they are supposed to adhere to the tooth structure, less technique sensitive and release fluoride, whereas resin-based sealants seem to offer improved long-term retention and wear resistance.[5] However, low retention rates are seen with the traditional glass ionomer sealants.[6]

For a sealant to convey any benefit it must be retained fully and if any portion of a sealant is lost, the associated benefits of the sealant are lost with it. One of the most important factors for sealant success is its marginal integrity, this can be assessed through microleakage evaluation. As the literature review has shown no concrete evidence regarding the superior efficacy of any material,[7] the present study was planned to estimate the marginal sealing ability of a glass ionomer and a resin-based fissure sealing material under different contamination conditions. The hypothesis for this study was that moisture contamination with one or more of the techniques before sealant placement being studied significantly decreases microleakage resistance of glass ionomer or resin-based sealant.

MATERIALS AND METHODS

The experimental study was conducted in the Department of Pediatric and Preventive Dentistry, Sharad Pawar Dental College after approval from the Institutional Ethical Committee of the Datta Meghe Institute of Medical Sciences (DU). A sample of 120 extracted mandibular 1st permanent molars was collected and stored in distilled water at room temperature until used. The non-carious teeth having stained fissures, those extracted for periodontal or orthodontic purposes, teeth with crowns free from any visible developmental defects or fractures were selected for the *in-vitro* study.

Water suspension containing pumice was used to clean the crown surfaces of all the teeth using a rubber cup and a slow-speed handpiece.[28] Cleaning of the teeth was done with distilled water for 10 seconds. The random division was done into 2 groups (A & B) of 60 each, based on the type of pet and fissure sealant used for sealing the occlusal surfaces. In Group A, teeth were sealed with Glass ionomer sealant (GC Fuji Triage, GC Corporation, Tokyo, Japan) while in Group B, teeth were sealed with a resin-based sealant (Clinpro™, 3M ESPE, St.Paul, USA). These two groups were further subdivided into 4 subgroups of 15 each depending upon the contamination condition under which sealant placement was to be performed. The four subgroups depending upon the different contamination conditions were control (A1 and B1), water contamination (A2 and B2), saliva contamination (A3 and B3) and saliva contamination with air drying (A4 and B4) by a single operator who performed the further experimental study.

The samples to were subjected to the allotted pit and fissure sealant. Samples in group A were subjected to conditioner (25% polyacrylic acid) for 15 seconds, while in group B, acid etching was done with 37% phosphoric acid for 15 seconds. In water contamination subgroup (Group A2 and B2), a drop of water was applied on the occlusal surface of the teeth and left undisturbed for 10 seconds. The excess water was then blotted with a small sponge leaving behind moist enamel surface. In salivary contamination subgroup (Group A3 and B3), artificial saliva was prepared and the allotted teeth were placed undisturbed for 10 seconds into the solution. For subgroup in which salivary contamination followed by air drying (Group A4 and B4), the teeth were submerged in similar artificial saliva for 10seconds followed by 5 seconds of surface air drying. After contamination under different conditions, sealant placement was done followed by 40 seconds of light-curing without the use of any bonding agent.

Thermocycling of all the samples was done at 5°C and 55°C temperature in the distilled water bath, with 60 seconds dwell time for about 500 cycles. The root apices of the teeth were sealed with self-cure acrylic resin and two layers of transparent nail varnish were applied to the occlusal surfaces of the teeth with a 1-mm margin between the varnish and the sealant.[8] Later the teeth were submerged in 1% methylene blue dye for 24 hours at room temperature, followed by 24 hours in distilled water.

After removal from distilled water, the teeth were allowed to dry and the nail varnish was scraped off. To prevent further dye washing-out and dehydration of the teeth, all the samples were wrapped in gauze moistened with saline solution in a sealed environment at room temperature until the sectioning procedure was performed. Three sections (mesial, centre and distal sections) were obtained for all the teeth with the help of double-faced diamond rotary at a low-speed (350 rpm) hand-piece. The thickness of each section was approximately 1mm.

STATISTICAL ANALYSIS

Sections were examined under a stereomicroscope at a magnification of 40X and the images were stored in a digital format by a single observer to eliminate the bias. (Table/Figure 6). The images were analysed using the UTHSCA image tool program (Version 3.00 for windows) to measure the depth of dye penetration in the sealant-enamel interface in millimetres. UTHSCSA image tool program developed at the University of Texas Health Science Centre, San Antonio, Texas is a free image processing and analysis program for Microsoft Windows'95™ or Windows NT™. This program

provides dimensional and greyscale measurements as image analysis.

RESULTS

Intergroup comparisons between glass ionomer group (A) and Clinpro group (B) were done for all the three contamination conditions and control group. The results revealed a significant difference between Group A and Group B in the salivary contamination subgroup (A3 and B3) (Table/Fig 1). However, no significant difference between the two sealant materials for the microleakage scores was found in the other three conditions (subgroups 1, 2 and 4)

Intragroup comparisons were performed in glass ionomer group (A) by One way ANOVA (Table/Fig 2) revealed significant difference ($p = 0.000$) within the four subgroups (A1, A2, A3 and A4). On multiple comparisons using the Tukey Test, saliva-air drying condition (A4) showed a high level of microleakage with statistically significant difference ($p = 0.005$) when compared with control (A1) and water contamination (A2) conditions (Table/Fig 3).

One way ANOVA was used for the intragroup comparisons in Clinpro group (A) which also showed significant difference ($p = 0.005$) within the subgroups (B1, B2, B3 and B4) (Table/Fig 4). Further, on multiple comparisons using the Tukey Test, saliva-air drying condition (B4) showed the highest level of microleakage ($p = 0.017$) that was statistically significant when compared with control (B1) and water contamination (B2) conditions (Table/Fig 5).

DISCUSSION

Fissure sealant therapy was introduced in the1970's as a method to prevent occlusal caries. Since then, fissure sealant application has increased steadily and its effectiveness has been proven through many studies. It forms an essential component of prevention-oriented practice which if applied at an appropriate time can have a long-lasting caries-preventive effect.[9]

Majority commercially available sealant materials have similar chemical composition, thus the knowledge of effectiveness and retention capacity of individual sealants is important. Microleakage at the sealant - tooth interface and sealant penetration depth are the two important criteria to measure the sealant efficacy.[10,18] Bacterial invasion and secondary caries due to microleakage make it one of the major drawbacks of pit and fissure sealants.[16,17] Laboratory studies such as microleakage tests can provide important information on possible clinical performance of newer restorative materials.[11]

Improper application technique is one of the main aetiology for sealant failure. Thus, it is important that the operator strictly adheres to the manufacturer's instructions of accurate sealant placement technique. Moisture, salivary pellicle, organic debris, oil from air compressors and hand-pieces are the various potential contaminants that may lead to bonding failure during sealant placement.[12] Hence, the isolation of the tooth from salivary contamination is one of the most important aspects of sealant placement, which is all the more difficult for dentists and hygienists treating children.

Properties like chemical bonding of sealant to enamel, minor polymerization shrinkage, coefficient of thermal expansion similar to that of the tooth structure, and fluoride release at long term to the dental enamel, offering a cariostatic action are presented by glass ionomer sealant. Another most important property is it's hydrophilic nature, making it compatible with the challenging environment of the oral cavity.[13] GC Fuji VII allows the dentist to seal a newly emerging permanent molar when isolation is problematic as manufacturers claim that even in a moist environment it has better adhesion and retention.

Resin-based sealants owing to their low viscosity, have a greater potential to flow, spread and penetrate more promptly over the surface. However, resin sealant is inconvenient to place in a moist environment. Significant reduction in bond strength between sealant and enamel is seen, due to the interference of sealant penetration. This occurs because of immediate enamel remineralization when in contact with saliva.[15] Newer brands of pit and fissure sealants continue to be established and one of them being unfilled flowable material with fluoride release, Clinpro. It has an impressive expected bonding ability and other advertised benefits, such as the colour change feature, ease of application, and absence of filler content.[4]

In the present study, a quantitative technique of dye penetration was used in which microleakage was expressed in millimetres of dye penetration from the border of the sealant. The UTHSCSA image tool program was used similar to that used by Singh et al .[20] This tool was a great advantage in eliminating the traditional scoring systems that made microleakage studies more subjective.

Both the materials performed relatively well in moisture-controlled conditions. This is following the results shown by Ashwin R et al. [21] who also did not find any difference in microleakage between Fuji VII and conventional light-cured unfilled resin sealant. However, the increased microleakage scores with Fuji VII under all conditions may be possible due to the formation of surface fractures after thermocycling causing an ensuing increase in marginal leakage. Additionally, there could be surface cracking, possibly due to dehydration following temperature changes and light-curing. Clinpro demonstrated better results under salivary contamination before sealant placement. This could be explained by the fact that when saliva contamination occurs for a second or more,

the tenacious surface coat present on the etched enamel cannot be easily removed thus inhibiting increased dye penetration.[22] The present results are in conjunction with those given by Rirattanapong P et al .[23] who attributed his results to the fact that incomplete enamel etching (conditioning) was performed in the glass ionomer group. Adhesion of the glass-ionomer sealant to the enamel surface is completely a chemical phenomenon as compared to the micromechanical bonding of resin-based sealants to the tooth structure as a result of acid etching. Additionally, Joshi K et al. mentioned that there can be some amount of disintegration of the glass ionomer sealant due to its solubility.[24] On the contrary to the present findings; Antonson S et al. stated that glass ionomer sealants can be an alternative whenever it is difficult to maintain isolation.[25]

In the present study, saliva-air drying condition showed the highest level of microleakage. This could be possibly due to the failure to eliminate all the air bubbles that maybe lead to decreased sealant thickness. This may be correlated to the findings of Hitt JC et al. where decreased bond strength for sealant in the dried saliva group was observed. This could be explained by the fact that enamel porosities are blocked by air-dried saliva, therefore reducing the number of enamel pores accessible for material penetration.[26] Besides, air drying might have lead to the increased desiccation and early solubility of the glass ionomer sealant.

In the present study, air drying was performed for 5 seconds before sealant application in both the groups. It is suggested that, in course of clinical contamination, air-thinning of the saliva for minimum 1- second may be sufficient before sealant placement.[19] Hence, from the present results, it can be suggested that complete dehydration of the surface should be avoided whenever placing glass ionomer or resin-based materials to achieve better wettability and sealant penetration.

Microleakage tests conducted *in vitro* with dye penetration technique are considered to be stricter than those performed in clinically.[27,29] Therefore, on the clinical level the response of these tested materials is more positive. Regardless of its restrictions, this study offers some data to support future research into the use of flowable composites as an alternative to glass ionomer based pit and fissure sealants.

CONCLUSION

Salivary contamination followed by air drying leads to the maximum degree of marginal microleakage in both glass ionomer (Fuji VII) as well as resin (Clinpro) based sealants as compared to other contamination conditions. Although Clinpro requires more application steps and is more technique sensitive, it performed better Fuji VII under both contaminated and uncontaminated conditions.

Author's Contribution:

All authors have contributed to various aspects of study right from study design, data collection, data analysis as well as preparing the final manuscript.

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