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COMPARATIVE EVALUATION OF MICROLEAKAGE OF DIFFERENT TYPES OF PIT AND FISSURE SEALANTS: AN IN VITRO STUDY

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ABSTRACT

Background: The purpose of this study was to investigate and compare the microleakage of three different pit and fissure sealants. **Materials and Method:** Total 45 therapeutically extracted premolars with absence of any carious lesion and anomalies were taken and equally divided into three different groups with fifteen samples (15) in each group. Group A: Conventional pit and fissure sealant (Helioseal –F), Group B: Glass ionomer cement(Fuji VII) based pit and fissure sealant . Group C: compomer (Compoglass Flow). Samples were cleaned with slurry of pumice and etched with phosphoric acid etchant. After thorough washing and drying, teeth were treated and cured with the respective sealants, followed by thermocycling and immersion in 5% methylene blue dye for forty eight hours. Teeth were then sectioned buccolingually and examined under stereomicroscope. The data was further subjected to statistical analysis. **Results:** Conventional sealant was showing significantly least microleakage as compare to Glass Inomer Cement and promising result with compomer. **Conclusion:** Besides many inventions and researches in dental materials, composite based Conventional sealant material is comparatively better than Compomer &Glass Inomer Cement as sealant materials.

KEYWORDS: Pit and fissure sealants, Microleakage.

INTRODUCTION

Pits and fissures are generally considered faults or imperfections in cuspal odontogenesis. They have been considered as the single most important feature leading to development of occlusal caries.[1] Although the occlusal surface represent approximately 10 % of the enamel surface at risk, they account for almost 50% of the caries in the human dentition.

The complex morphology of occlusal pits and fissures makes them an ideal site for retention of bacteria and food remnants, rendering the performance of proper hygiene difficult or even impossible. Another factor responsible for the high incidence of occlusal caries is the lack of salivary access to the fissures as a result of surface tension, effectively preventing remineralization and reducing the effectiveness of fluoride.[2] Early attempts to protect pits and fissures, such as physical blocking of fissures with zinc phosphate cement, prophylactic odontotomy and fissure eradication were all tried, but with little success. Similar results were met with chemical agents like ammoniacal silver nitrate, zinc chloride, potassium ferrocyanide, and copper cements.

With the introduction of acid etching by Buonocore in 1955, bonding became a new technology and a further step in its use was the prevention of pit and fissure decay. With the formulation of Bis-GMA resin by Bowen in 1962, resin sealant methods were developed. This resin continues to form the basis of presently available sealants.[3]

An important factor for sealant success is its marginal integrity, which can be appreciated by evaluating microleakage. Microleakage or marginal leakage may be defined as the ingress of oral fluids into the space between the tooth and restorative material.[4]

Microleakage may support the caries process beneath the sealant, so the ability of the sealant to adequately seal the pit or fissure and prevent microleakage is important. Hence this study was to assess the microleakage of conventional pit and fissure sealants, Glass ionomer sealant type VII, and compomer.

MATERIALS AND METHOD

Forty five premolars extracted for orthodontics reason with absence of caries or anomalies, were collected. Samples were thoroughly cleaned by water and then were preserved in normal saline. Cleaning of occlusal fissure surfaces was done with pumice slurry. Samples were divided into three groups containing 15 samples in each group. Samples were etched with 35% phosphoric acid etchant gel for 15 seconds, washed and dried with oil free air syringe. Sealants were placed over the pit and fissure area according to manufacturer's instruction in the respected groups.

Table 1: Different type of materials and its manufacturer.

Name of the material	Manufacturer
Conventional pit and fissure sealant	Helioseal F, Ivoclar, Vivadent
Glass ionomer cement type VII	Fuji VII, GC Corporation; Tokyo
Compomer	Compoglass Flow

The treated teeth were then stored in sealed containers containing distilled water at 37 0C for 24 hours. Later on samples were thermocycled for about 550cycles between 2 0 C and 58 0 C with a dowell time of 60 seconds. All tooth surfaces were triple coated with finger nail varnish, with the exception of a 0.5-1.0 mm window around the sealant margins. The teeth were immersed in 5% methylene blue for seven days, after which they were rinsed in tap water and the superficial dye was removed gently with slurry of pumice and rubber cup. A diamond disc at slow speed was used to section the teeth longitudinally in a bucco-lingual direction. Sections of thickness 1-2 millimeters (approximately) were obtained for every tooth. The microleakage was assessed by viewing all the treatment groups under stereomicroscope at a magnification of 10X. The scoring criteria for the microleakage assessment were followed according to Smales et al (1997).

0	No dye penetration
1	Dye penetration upto 1/4th of the fissure.
2	Dye penetration upto ½ of the fissure.
3	Dye penetration upto 3/4th of the fissure.
4	Complete dye penetration.

RESULTS

Table 2: Mean values of microleakage in various groups.

Groups	N	Mean±Std. Deviation	Std. Error
Group1	15	2.20 ±1.146	.296
Group2	15	3.33 ±.816	.211
Group3	15	3.20 ±.941	.243

Table 3: Mean rank scores between the groups following Kruskal – Wallis Test.

Groups	N	Microleakage (Mean Rank)	Chi Square	p value
Group A	15	15.27	8.676	.013*
Group B	15	27.57		
Group C	15	26.17		

* Significant ($p<0.05$)
** Non – significant ($p> 0.05$)

Table 4(a): Intergroup comparison of the mean rank of microleakage in group A and group B by Mann-Whitney test.

Groups	N	Microleakage (Mean Rank)	Mann-Whitney	p value
Group A	15	11.40	51.00	0.010*
Group B	15	19.60		

*significant ($p<0.05$)
** Non – significant ($p> 0.05$)

Table 4(b): Intergroup comparison of the mean rank of microleakage in group B and group C by Mann-Whitney test.

Groups	N	Microleakage (Mean Rank)	Mann-Whitney	p value
Group B	15	15.97	105.500	0.775**
Group C	15	15.03		

*significant ($p<0.05$)
** Non significant ($p>0.05$)

Table 4(c): Intergroup comparison of the mean rank of microleakage in group A and group C by Mann – Whitney test.

Groups	N	Microleakage (Mean Rank)	Mann-Whitney	p value
Group A	15	11.87	58.00	0.023*
Group C	15	19.13		

* Significant ($p<0.05$)
** Non- significant ($p>0.05$)

1. The data for this study was analyzed using the Kruskal –Wallis & Mann – Whitney Test statistical test.
For the purpose of statistical interpretation p value of 0.05 was considered statistically significant. Mean value of microleakage in Group A was 2.20±1.146, Group B was 3.33±0.816 and Group C was 3.20±0.941. It was noted that microleakage value was highest in Group B followed by Group C and least in Group A. (Table 1).

2. Mean rank value of microleakage in various groups using Kruskal- Wallis followed by Chi Square Test.
The mean rank score in Group A was 15.27, Group B 27.57, Group C 26.17. It was noted that Group A had lowest mean rank followed by Group C and Group B. The mean rank of microleakage among all the groups was found to be significant.

3. Intergroup comparison of microleakage among various groups is assessed by Mann – Whitney Test.
The Mann – Whitney test showed a statistically significant difference between Group A and Group Band between Group A and C with a p value of 0.010and 0.023 respectively. However intercomparison between Group B and Group C showed insignificant difference with a p value of 0.775. The bar diagram showed the mean rank of microleakage among the three groups and it revealed that group A had the lowest microleakage followed by Group C and Group B.

DISCUSSION

The susceptibility of occlusal surfaces to caries has often been related to the morphology of pit and fissures on these surfaces, which are considered to be an ideal site for the retention of bacteria and food remnants rendering mechanical means of debridement inaccessible. Other factors responsible for the high incidence of occlusal caries include the lack of salivary access to the fissures as a result of surface tension effectively preventing remineralization and reducing the effectiveness of fluoride.[2]

Sealing pits and fissures in teeth is a widely advocated preventive technique.[5] Sealants have been developed to protect the pit and fissures from caries by preventing the impaction of food and bacteria, which produce acidic conditions that result in caries initiation. Microleakage which is defined as the clinically undetectable passage of bacteria, fluids, molecules, or ions between the cavity wall and the applied restorative material, is the main reason for the failure of the sealant.[4]

Infact in the presence of any microleakage, the anticariogenic properties of the sealant are jeopardized and a caries process may begin underneath. A sample size of 45 was selected after confirming the statistical validity for the study. The selection criteria was in accordance to Burrow MF, Burrow JF, and Markinson.[6] All the 45 sample teeth were cleaned of blood and saliva by passing them through running tap water and using a tooth brush and stored in saline till the initiation of the study. The samples were then embedded in plastic mould with the help of synthetic resin of self-curing acrylic resin (Pyrax) to ease the handling of the sealant material. The occlusal surfaces of the teeth were then subjected to pumice prophylaxis.

Ansari G , Oloomi K, Eslami B (2004) stated that the use of pumice slurry at slow speed handpiece to clean the tooth surface is the method most widely accepted as it helps in removing plaque and debris through the enamel surface, that improves the sealant retention and reduces the microleakage.[7] In contrast to our study Julie A. Blackwood and Diane C. Dilley (2002) reported that there was no statistical significant difference in microleakage when sealant was placed after pumice prophylaxis, bur preparation or air abrasion.[8]

The successful bonding to enamel is dependent on adequate and proper conditioning of enamel. The acid-etch technique described by Buonocore is still widely used.

Phosphoric acid has been used routinely for conditioning the enamel prior to sealant application. It is used in concentrations of 30-50%, with the etching time ranging from 5-120 seconds.9In the present study, 35% phosphoric acid gel was used with an etching time of 15 seconds. Tandon et al (1989) and Duggal et al (1997) have also observed that increased etching time does not effect the effectiveness and penetration of sealants which is similar to our study, wherein we have also done the etching for 15 seconds.[10,11] Following application of the sealant materials all the samples were stored in saline for 24 hours and subjected to thermocycling at 520C to 580C with a dowell time of 60 seconds, to simulate the oral conditions. Following thermocycling all the sample teeth were triple coated with finger nail varnish with the exception of a 0.5-1.0 mm window around the sealant margins and immersed in 5% methylene blue dye for 48 hours.

Microleakage assessment can be done both qualitatively and quantitatively. In our study we have used qualitative technique of dye penetration to assess the microleakage. Various dyes such as, silver nitrate, basic fuschin, can be used. 5% methylene blue was used in our study because it was equally efficient, easily available, and convenient and the samples could be kept in dye for a period of one month.[5,13] Following dye immersion, teeth were sectioned longitudinally in a bucco-lingual direction with a low speed diamond disc to obtain the section of 1-2 mm thick. Microleakage scores were accessed under stereomicroscope.

In microleakage studies, it is not possible to obtain high level of magnification and depth of focus as with a scanning electron microscope. Thus all the samples were viewed under stereomicroscope .Stereomicroscope uses two separate optical paths with two objectives and eyepieces to provide slightly different viewing angles to the left and right eyes. This arrangement produces a three-dimensional visualization of the sample being examined.[13]

The samples were then subjected for statistical analysis. In the present study, all the groups showed some amount of microleakage. This finding is in accordance to those reported by Theodoridou Pahini et al who stated that microleakage can be expected in all restorative materials.

The most likely explanation for this is that the thermal expansion coefficient of the sealants is significantly different from that of enamel.[14]

The result revealed that there was a significant difference found in the mean microleakage among all the groups. It was observed that the maximum microleakage was seen in Group B (Glass Ionomer cement type VII) followed by group C (Compomer) and least in group A (Conventional Pit &Fissure Sealants).Though Fuji VII has many advantages such as pink shade, command set and has high fluoride release capacity but it showed maximum microleakage probably due to cohesive failure of the cement. These findings were very similar to Herle GP et al (2004), Ganesh M and Tandon S (2007) wherein cohesive failure of the Glass Ionomer Cement and fracture of material was seen in almost all the specimens.[15,16] But in contrast to our study Ashwin et al (2007) found no statistical difference in microleakage between Glass Ionomer Type VII cement and resin based composite restoration as a sealant.[17] Inter group comparison of group A and group B using Mann – Whitney test (Table 4a) revealed that there was statistically significant difference in the mean microleakage between the two groups which was similar to the study done by Shilpa G et al (2011) and Joshi et al(2013).[18,19]

Intergroup comparison between group A and C revealed statistically significant result (p value of 0.023). There may be many reasons for the greater microleakage in compomer than conventional sealants. The most likely explanation for this is the thermal expansion co-efficient of the sealants are significantly different from that of enamel, which is applicable to group A and group C, but not group B, which was similar to the study done by Joshi et al.[14,19]

Among group B and group C the results revealed that there was statistically insignificant result.(Table 4b). However, this in -vitro study can be supported with further vivo study, under realistic physiological conditions, which may adversely affect dentin bonding and sealant adaptation. In extracted teeth, the collagen fibrillar network of dentin may collapse and prevent proper resin penetration in dentin. These facts might explain the statistically similar behavior of the tested materials. Microleakage studies have their own limitations and should be considered at the theoretical level. They should be assisted in clinical practice by relating the sealant with its clinical performance .So, before the compomer is extensively used as a sealant, it is mandatory to match the in-vitro and in-vivo studies.

CONCLUSION

The results observed in the present study suggested that, Composite based conventional pit and fissure sealant was the best material amongst three different materials in terms of least microleakage. Compomer gave the promising results whereas GIC was the least successful pit and fissure sealant material.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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