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Comparative evaluation of the micro leakage of various commercially available pit and fissure sealants using stereomicroscope - An in-vitro study

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Abstract

Aim: The aim of this study was to evaluate and compare the microleakage of commercially available pit and fissure sealants.

Material and Method: 40 freshly extracted sound human molar teeth extracted for orthodontic or periodontal reasons which were divided into four groups (Group A- Ammdent, Group B- Prevest PF seal, Group C- Clinpro and Group D- BeautiSealant). All the specimens were subjected to thermocycling for 500 times between 5 and 55 degrees. After 2% methylene blue dye penetration, specimens were sectioned and scored under stereomicroscope. Data were analysed using Anova and Tukey’s test ($P < 0.05$).

Result: It was observed that, Group D (BEAUTISEALANT) had lowest mean value of microleakage (0.30), while Group A (AMMDENT) had highest mean (2.80).

Conclusion: Beautisealant is found to be an effective sealant material in terms of best marginal sealing ability when compared with Clinpro followed by PF seal and Ammdent.

Keywords: Microleakage, Pit and fissure sealant, Self-etching sealant.

Introduction

Pits and fissures are generally considered faults or imperfections in cuspalodontogenesis. They have been considered as one of the most important features leading to development of occlusal caries. Their complex morphology makes them an ideal site for retention of bacteria and food residue.[1] Because of poor accessibility of deep pits and fissures these food remnants and bacterias do not get flushed by the cleansing action of saliva and oral hygiene aids. Early attempts to protect pits and fissures, such as physical blocking of fissures with zinc phosphate cement, prophylactic odontomy and fissure eradication were all tried but with little success may be because of the inaccessibility and complex morphology.

With the introduction of acid etching by Buonocore in1955, bonding became a new technology and a further step in its use was the prevention of pit and fissure decay. Where in 1960, Cueto invented the first sealant material, methyl cyanoacrylate, but it was not marketed because this material was prone to bacterial disintegration in the oral cavity. Later on, BIS-GMA (bisphenol-a-glycidyl dimethacrylate) resin was introduced by Bowen in 1962, which had the ability to produce a successful bond with the etched enamel and at the same time it's resistant to degradation. And finally, in 1972, Nuva Seal became the first successful sealant introduced into the market.[2]

The properties required of an ideal fissure sealant include biocompatibility, anti-cariogenicity, adequate bond strength, good marginal integrity, resistance to abrasion and wear and cost effective. Thus, an important factor for sealant success is its marginal integrity, which can be appreciated by evaluating microleakage which is ingress of oral fluids into the space between the tooth and restorative material.[3] 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.

Since ages manufacturers have added filler particle, fluorides, colour etc to improve strength, retention, anti-cariogenic properties of these sealants. Conventional resin-based sealants required etching, bonding before the placement of sealants thus became quite time consuming. The use of phosphoric acid etching not only required laborious steps but also destroy healthy tooth structure with the damaging effects of harsh acids. Thus, a new class of self-etching pit and fissure sealant in the name of BeautiSealant has been introduced which is a giomer based sealant which eliminates use of acid etching. This giomer has the unique S-PRG (Surface Pre-Reacted Glass ionomer) filler particle that releases ions and assisting in remineralisation process from household dental hygiene products such as toothpaste.[4]

Hence this study was aimed to comparatively evaluate the microleakage of various commercially available pit and fissure sealants using Stereo-microscope.

Material and methods

The present in vitro study was carried out in the Department of Pediatrics and Preventive Dentistry, D.J. College of Dental Sciences & Research, Modinagar in collaboration with Subharti Dental College, Meerut. Forty freshly extracted sound human molar teeth, extracted for orthodontic or periodontal reasons fulfilling the inclusion criteria were taken as a sample for the study.The following inclusion criteria was used -teeth having occlusal, deep

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and narrow pits and fissures, Non-carious teeth those were free from restoration and fluorosis, Teeth without any developmental anomaly and No sealant present on teeth. The extracted teeth were excluded if crown of the tooth fractured during extraction.

After extraction, all teeth were cleaned of gross debris using ultrasonic scaler, disinfected with hydrogen peroxide solution, autoclaved and then stored in distilled water at room temperature until used for the experiment. All fissures in each tooth were cleaned for 15 seconds with aqueous slurry of pumice and water using a polishing bristle brush in a slow-speed contra-angle hand piece. The teeth were rinsed with air-water spray. The selected teeth were used within 3 months of collection as per recommendations of Occupational Safety and Health Administration (OSHA).

The collected 40 samples were randomly divided into the following four groups with 10 samples in each group and color coded accordingly (Figure 1). [Group A- (Green) Ammdent pit & fissure sealant; Group B – (Brown) PrevestDenPro PF seal; Group C- (Pink) ClinproTM sealant (3M ESPE); Group D- (Purple) BeautiSealant]. The prepared teeth in each group were sealed according to manufacturer's instruction. Care was taken not to incorporate air bubbles. If present they were removed with an explorer and then light polymerized. After sealant application, all samples were stored in saline at 37^0 C for 48 hours in separately labeled sterile containers to simulate the oral conditions and later were subjected to thermocycling. Each sample was tied at the lower end of 10 cm ligature wire in such a manner that around 7 cm of wire was left free to hold the sample easily during thermocycling. Five samples were thermocycled at a time, in water baths for 500 times between 5 and 55degrees with a dwell time of 30 seconds in each bath and a transfer time of 30 seconds. After thermocycling, the ligature wire tied around each sample was cut using the wire cutter and samples were dried using 3-way syringe for 10 seconds to remove any moisture incurred in the storage medium. The apices of teeth were sealed with blue sticky wax and finger nail varnish was triple coated on all tooth surfaces except the area of pits and fissures. The teeth were immersed in 2% methylene blue dye for 48 hours, after which they were thoroughly rinsed under running water and air dried for 5 minutes. All the teeth were marked with a coloured marker along the centre of restoration. A diamond disc at slow speed in a micromotor straight hand piece was used to section the teeth longitudinally in a mesiodistal direction during which continuous irrigation with distilled water through a syringe was done. Out of 80 sections obtained from 40 samples of teeth, randomly again 40 sections were selected which were complete and not fractured or chipped off (Figure 2).The microleakage was assessed by viewing all the samples of treatment groups under the stereomicroscope at a magnification of 40X. The scoring criteria for the microleakage assessment were followed according to Smales et al (1997).[5] 0 = No dye penetration, 1 = Dye penetration upto 1/4th of the fissure, 2 = Dye penetration upto 1/2of the fissure, 3 = Dye penetration upto 3/4th of the fissure, 4 = Complete dye penetration.

Statistical analysis

The data for this study was analyzed using the ANOVA and Tukey's statistical test. For the purpose of statistical interpretation p-value of 0.05 were considered statistically significant and the following results were obtained.

Results

The mean value of microleakage was highest (2.80) for Group A (ammdent), followed by group b (prevest), and then Group C (clinpro) and lowest (0.30) for Group D (beautisealant). On applying one way anova, a significant difference at p value of 0.001 was observed in all the

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groups. When intercomparison of various groups were done using Tukey's (Post Hoc tests), Group D was found to be significantly less with rest of the three groups, while statistically insignificant differences were found between Group A, Group B and Group C. (Table 1).

Discussion

The result from the present study revealed that the mean microleakage was observed to be least in (Group D) Beautisealant. A similar study was done by AtaolaE et al(2017)[6] on Sealing effectiveness of fissure sealants bonded with universal adhesive systems in which micrleakage of two different pit and fissure sealants was evaluated and it was reported that the microleakage of Giomer based Beautisealant was less than conventional acid-etch fissure sealant. Another study done by Hatirli Het al (2018)[7] on microleakage and anticariogenic effect of S-PRG filler-containing pit and fissure sealant also reported that S-PRG filler-containing pit and fissure sealant showed less microleakage and higher anticariogenic effect than that of flowable resin sealant.

Beautisealant, the Giomer-based pit and fissure sealant which contain surface prereacted glass-ionomer (S-PRG) fillers that exhibit strong bioactive and cariostatic properties and appear to be particularly desirable for fissure sealing purposes in high-risk pediatric patients and in cases of difficult isolation. This fissure sealant is simple and gentle on the tooth surface and consists of the BeautiSealant primer which is a self-etching primer that shortens the conventional treatment time by eliminating the treatment steps of etching and rinsing. The HEMA-free primer contains acidic monomers in an acetone/water solvent, seeping deeply into pits and fissures and bonds equally to enamel or dentin preparing the tooth surface for a secure and long-lasting bond. The treatment is gentle, as the demineralised and dehydrated effect of the phosphoric acid etching on healthy tooth substance is avoided while still achieves a sheer bond strength of 19.5 mpa, which is better than fissure sealing with phosphoric etching which is in harmony with the previous study done by ataola E et al(2017)[6]It was stated in previous literature that self-adhesive sealants had less microleakage due to higher consistency, smaller gap at the tooth/sealant interface and lack of multiple layers (absence of poor bonding layer present in other bonding systems).

Another possible reason explaining lower microleakage of giomer based Beautisealant is higher hygroscopic expansion of these materials and their relatively low polymerization shrinkage.

Beautisealant showed the statistically significant less microleakage than clinpro, PF seal and Ammdent pit and fissure sealants. Although Clinpro-Resin based unfilled sealant was found to have less microleakage than PF seal and Ammdent pit and fissure sealants because of the fact that Clinpro being resin-based sealant create mechanical bond with underlying etched enamel rods by flowing into microporosities and forming resin tags. Formation of the resin tag indicates sealing ability. Another reason is that being unfilled it should be less viscous to allow better penetration onto conditioned enamel surfaces. Since penetration is inversely proportional to viscosity, therefore an unfilled resin would be penetrated more deeply into the fissure system and perhaps be better retained according to the results of previous studies done by Kumaran P (2013)[8]. In this regard, the unfilled, resin-based sealant Clinpro Sealant showed the highest and the highly-filled resin-based sealant PF Seal showed the least penetration depth and hence more microleakage.

The reason for Ammdent, the traditionally used pit and fissure sealants to be highest in microleakage because of its hydrophobic nature and henceforthcannot be applied in the areas there is moisture, (Ratnaditya A et al(2015)[9].

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Another reason could be the fact that these sealants being non resin based obtain less retention because of lack of resin tags in microporosities formed in etched enamel, causing more polymerization and hence more microleakage which is in accordance with the study done by **A.** TopalogluAk et al (2010**)**[10]. Prevention of dental diseases at the right time not only reduces the disease complication but also lessens the time required for treatment along with the economic burden incurred by parents and dental sealants are very effective agents in such terms.[11]

Conclusion

Within the limitation of this in vitro study the following conclusions were drawn:

It is concluded that Beautisealant is found to be an effective sealant material in terms of best marginal sealing ability when compared with Clinpro, PF seal and Ammdent.

Clinical significance

Beautisealant appear to be particularly desirable for fissure sealing purposes in high-risk pediatric patients and in cases of difficult isolation as it shortens the conventional treatment time and has excellent microleakage resistance.

Manufacturer name

Stereomicroscope (leica mz125, germany); autoclave (unique clave – c); ammdent (ammdent); prevest pf seal (prevest-denpro); clinpro (3m espe); beautisealnt (shofu).

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Legend Table and Figures

Table 1: Mean values of microleakage in different groups

GROUP	N (Sample size)	Mean	Std. Deviation	Std. Error Mean	F-value	p-value
Group A (AMMDENT)	10	2.80	1.398	0.442	7.200	0.001*
Group B (PREVEST PF SEAL)	10	2.40	1.350	0.427		
Group C (CLINPRO)	10	2.10	1.663	0.526		
Group D (BEAUTISEALANT)	10	0.30	0.483	0.153		

Post-hoc analysis by Tukey's test						
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	0.400	0.582	0.984	-1.23	2.03
	C	0.700	0.582	0.853	-0.93	2.33
	D	2.500	0.582	0.001*	0.87	4.13
B	C	0.300	0.582	0.991	-1.33	1.93
	D	2.100	0.582	0.006*	0.47	3.73
C	D	1.800	0.582	0.023*	0.17	3.43

Significant $p < 0.05$

Figure 1: Division of samples for microleakage evaluation

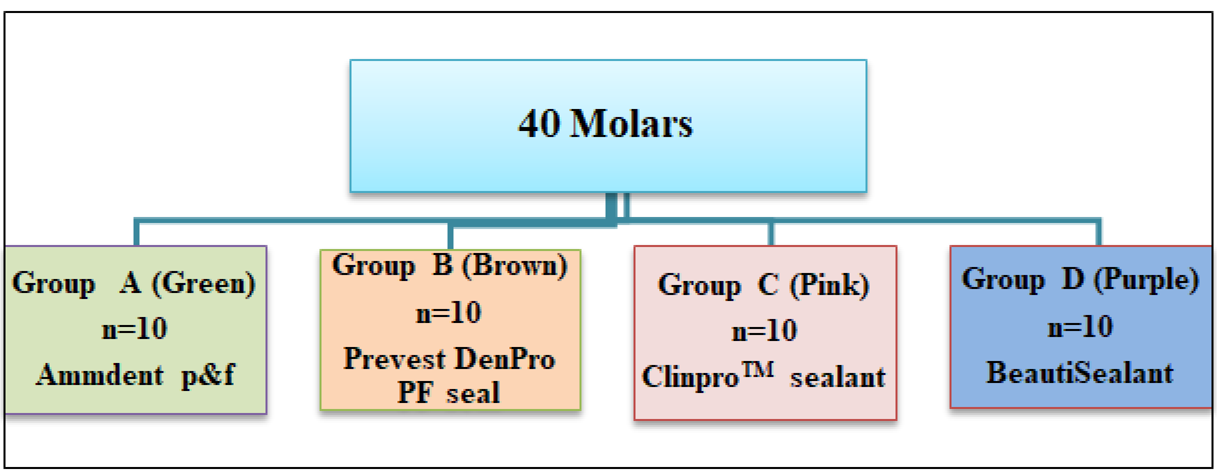

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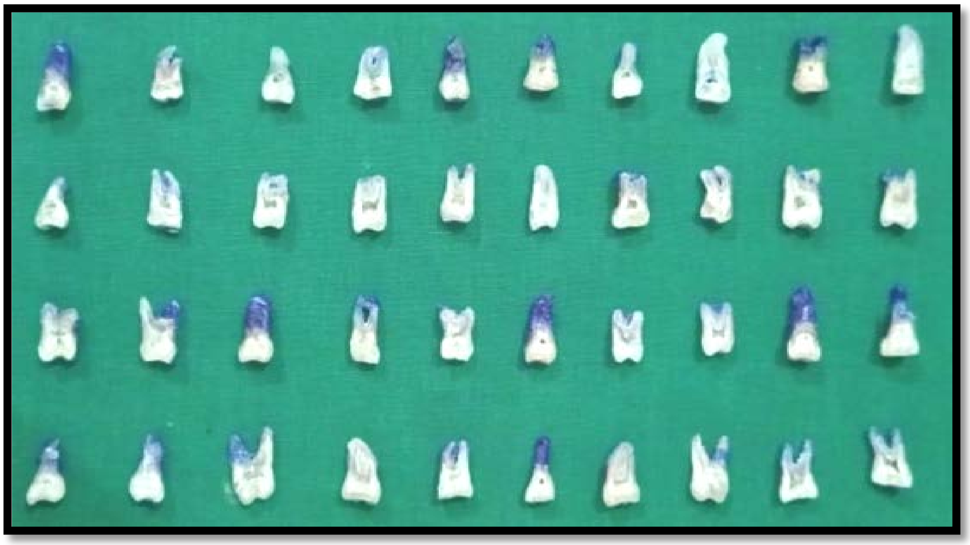
Figure 2: Sectioned samples of all four groups.



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