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LENGTH OF RESIN TAGS IN SELF ETCHING SEALANT WITH AND WITHOUT PRE ETCHING WITH PHOSPHORIC ACID. AN INVITRO COMPARATIVE STUDY

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ABSTRACT

Background: Caries has been a problem for individuals of all age. The teeth at highest risk for caries are the permanent first and second molars. Pit and fissure dental sealants have reduced caries over 70%. Driven by modern concepts of Minimally Invasive Dentistry and recent developments in adhesives technology; PF SEAL SE, a faster, easier, and gentler sealant system that eliminates the need for acid etch and rinse is created. The aim of this study is to compare the retention of PF SEAL SE (Self Etching Sealant) with and without pre etching with 37% phosphoric acid by determining the depth of resin tag penetration. **Materials and methods:** Twenty freshly extracted maxillary first premolars were randomly divided into two groups. Length of resin tags in self etching sealant with and without pre etching with phosphoric acid was determined using scanning electron microscope. **Results:** Group A (PF SEAL SE with pre etching) showed good penetration to the tooth surface with a mean value of resin tag length obtained as 18.98 microns. Whereas Group B (PF SEAL SE without pre etching) no resin tag formation was observed, rather a gap formation was seen at resin tooth interface with a mean value of 61.22 microns. **Conclusion:** PF SEAL SE does not exhibit any efficient bonding and penetration to the tooth surface. But the penetration capacity of the sealant might be improved by previous acid etching of the dental enamel. Therefore, utilization of previous acid etching or removal of prismatic enamel layers may result in superior retention.

KEYWORDS: Dental caries, self etching sealants, scanning electron microscope, resin tags.

INTRODUCTION

Dental caries has been a problem for individuals of all ages. Studies reveal that 23% of adults between the ages of 20 and 64 and 23% of children between ages 2 and 11 have untreated dental caries. The occlusal surfaces of teeth that contain deep pits and small fissures have been recognized for their high caries susceptibility and undoubtedly are more prone to decay due to the unique morphology of the pits and fissures. The teeth at highest risk for caries are the permanent first and second molars.[1] Fissure sealants prevent caries by sealing the fissures from the oral environment with thin resin coatings on the pits and fissures of the occlusal tooth surfaces. Pit and fissure dental sealants have reduced caries over 70%.[2]

A sealant is effective in preventing caries only when it is successfully retained in the fissures. Hence the retention becomes a major factor in influencing the efficacy of the sealant. The retention of resin based Pit and Fissure Sealant is through micromechanical interlocking between the resin and the etched enamel. Mechanical retention of sealant is the direct result of resin penetration into the porous enamel forming tags. This occurs by capillary action. The resin monomer polymerizes and becomes interlocked with the enamel surface.[3] Thus, it can be postulated that, the longer the resin tags, the lesser will be the micro leakage. Other than surface tension, the viscosity of the sealant also influences the depth of penetration of sealants.[4] With low viscosity sealants, there is a greater potential of the sealant to flow, spread and penetrate more rapidly into etched enamel surface.[5]

Clinicians face certain challenges for effective placement of traditional Pit and Fissure Sealants; which include moisture control, manipulative technique sensitivity and time consuming procedure. High quality polymeric restorative materials are desirable, especially when treating children with unpredictable tolerance, patience and cooperation.[6] Taking all this into account, dental

manufacturers concentrated their efforts to offer a material with less application time, which can be placed with lesser steps and is less technique sensitive, thus increasing the potential success of the material. One of these newer materials is the Self-Etching Pit and Fissure Sealant.[6]

Driven by modern concepts of Minimally Invasive Cosmetic Dentistry and recent developments in adhesives technology, Prevest Denpro created a faster, easier, and gentler sealant system that eliminates the need for phosphoric acid etch and rinse steps entirely i.e., PF SEAL SE. It is a light curing self-etch pit and fissure sealant fortified with active nano hydroxapatite that has the ability to re- mineralize tooth. However, there appears to be few research studies comparing such materials with that of conventional sealants. Therefore, the purpose of this study is to compare the retention of PF SEAL SE (Self Etching Sealant) with and without pre etching with 37% phosphoric acid by determining the depth of resin tag penetration.

MATERIALS AND METHODS

Twenty sound freshly extracted maxillary first premolars of patients indicated for orthodontic extractions were collected at the Department of Pedodontics and preventive Dentistry, Royal Dental College, Palakkad, Kerala. The collected teeth were cleaned of any adherent deposits/debris with an ultrasonic scaler and stored in normal saline. Pretreatment of the occlusal surfaces were done by cleaning the teeth with pumice slurry and were washed and dried. The teeth were then randomly divided into two equal groups (10 premolars each).

Group A: Sealant (PF SEAL SE) application with etching.

Group B: Sealant (PF SEAL SE) application without etching.

Procedure for Pit and Fissure Sealant application:

Pit & Fissure Sealant	Composition	Manufacturer
PF SEAL SE	Urethane Dimethacrylate Triethylene Glycol Dimethacrylate Methacrylated phosphoric acid esters Silanated Barium Glass Powder Amorphous Silica Curing Agents and Stabilizer	PREVEST DENPRO

Group A (PF SEAL SE with pre etching)

Occlusal surfaces of the teeth were etched with 37% phosphoric acid for 15 sec and thoroughly rinsed with water. The teeth were then dried with a mild oil-free air stream to achieve a characteristic frosted chalky white appearance of enamel. PF SEAL SE was dispensed onto the prepared occlusal surfaces using a dispensing tip. A thin layer of sealant was brushed onto the occlusal surface with moderate pressure for about 15 sec. Excess material around the margins was removed using the provided brush. Polymerized for 20 sec using light curing unit (LED: BLUEPHASE ® C5 curing-light, 500 mW/cm^2, 430- 490 nm, IVOCLAR VIVADENT).

Group B (Direct Application of PF SEAL SE)

According to the manufacturer's instructions PF SEAL SE was dispensed onto the preparation using dispensing tip. A thin layer of sealant was brushed onto the occlusal surface with moderate pressure for about 15 sec. Excess material around the margins was removed using the provided brush, and then light cured for 20 sec. The root portion of each tooth was cut and the crowns were sectioned bucco-lingually with a carborundum disc. For each tooth one of the sections was selected randomly and discarded and the other half of the section was prepared for scanning electron microscopy. The selected sections were polished using a carbide stone. The polished sections were then decalcified using 37% PA for 15 seconds to etch away enamel mineral components not protected by sealants and then rinsed and stored in distilled water.

Procedure of SEM for evaluating the length of resin tags

The tooth sections were then dried thoroughly under the heat lamp, mounted on aluminum stub (Fig 1). These mountings were then placed inside an ion spluttering device (EMITECH K550X SPUTTER COATER, ENGLAND) for 30 min using vacuum evaporation at 200 - 300 Aº. The surfaces were coated with pure gold and the stubs were placed in the vacuum chamber. The gold spluttered sections were then examined using SEM; SEM Model Quanta 250 FEG (Field Emission Gun) attached with EDX Unit (Energy Dispersive X-ray Analyses), with accelerating voltage 30 K.V. and photographs of the sections were obtained. The resin tag lengths were then measured and the average values were taken from each photograph.

Fig 1: Gold spluttered samples in SEM stub.

RESULTS

Results showed that in Group A where the samples were subjected to pre etching with phosphoric acid gel, the sealant (PF SEAL SE) showed good penetration to the tooth surface with a mean value of resin tag length obtained as 18.98 microns ***(Table 1***). In Group B, where the samples were subjected to direct application of the sealant (PF SEAL SE), no resin tag formation was observed rather gap formation was seen at resin tooth interface with a mean value of 61.22 microns ***(Table 2***).

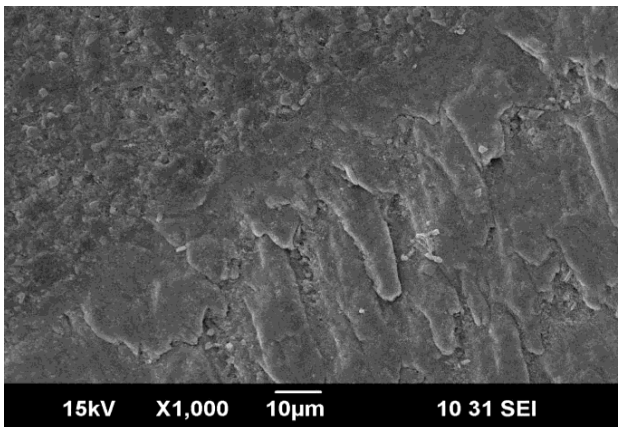

Fig 2: SEM image showing the resin tags in Group A (PF SEAL SE with pre etching).

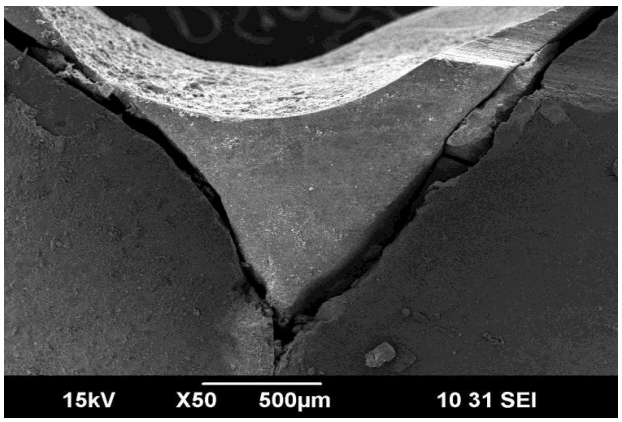

Fig 3: SEM image showing the gap formation in the resin tooth interface in Group B (PF SEAL SE without pre etching.

Table 1: Average length of resin tag formation for each sample in Group A.

Group A (with pre etching)	Resin tag penetration in microns	Mean
1	16.33	18.98
2	22.54	
3	17.56	
4	17.11	
5	16.24	
6	25.83	
7	18.20	
8	16.59	
9	17.24	
10	22.25	

Table 2: Average value of gap formation at the tooth resin interface in Group B.

Group B (without pre etching)	Gap in microns	Mean
1	59.25	61.22
2	60.21	
3	68.65	
4	72.14	
5	55.87	
6	60.55	
7	62.16	
8	55.44	
9	58.26	
10	59.72	

DISCUSSION

The cariostatic properties of sealants are attributed to the physical obstruction of the pits and fissures. This prevents colonization of the pits and fissures with new bacteria and also prevents the supply of fermentable carbohydrates to any bacteria remaining in the pits and fissures.[7] Requisites of an efficient sealant include: viscosity allowing penetration into deep and narrow fissures, adequate working time, rapid cure, good and prolonged adhesion to enamel, low sorption and solubility, resistance to wear, minimum irritation to tissues, and cariostatic action.[8]

In this study, maxillary first premolars extracted for orthodontic purpose, which were free of caries, developmental defects, enamel micro fractures and discoloration were included. Pumice prophylaxis was used for cleaning the occlusal surfaces of premolars prior to etching. Blackwood *et al*.[9] showed that between enameloplasty, air abrasion and pumice prophylaxis, the least micro leakage was seen with the conventional pumice prophylaxis.

The SEM was used to measure the length of resin tags as the SEM can produce very high-resolution images of a sample surface, and reveal details about less than 1 to 5 nm in size. Due to the very narrow electron beam, SEM micrographs have a large depth of field yielding a characteristic three-dimensional appearance useful for understanding the surface structure of a sample.[10] In the present study SEM examines the resin tag penetration depth thereby helps in the assessment of bonding efficacy of the adhesives. According to Ferrari *et al*.[11] in SEM low magnifications (×1000) shows the uniformity of the etch pattern of enamel and the density and real depth of the resin tags, whereas high magnifications (×3500) demonstrate the morphological characteristics of the resin tags penetrating enamel although the evaluations have been essentially subjective regarding the depth of etching.

SE sealants are a promising development in adhesive dentistry, especially regarding reduction of the necessary application steps and the possibility of chemical

interaction with hydroxyapatite coated collagen fibers.[12] However, bonding to enamel still remains critical and is controversially discussed by various authors.[13,14,15] The present study evaluated the effect of an optional etching with 37% phosphoric acid on resin tag length to intact enamel. Investigations revealed that adequate bonding to intact enamel with self etching systems alone cannot be achieved and will require etching.

Despite the less aggressive etching pattern and shallower resin tag formation, sufficient micro-mechanical interlocking and good bond strengths may be obtained with mild self etching systems. This may be the combined result of the simultaneous demineralization and resin monomer infiltration and the remnant hydroxyapatite left attached to the collagen, which may serve as receptor for additional chemical adhesion.[12,13,14] In the present study, in Group B in which the samples were subjected to the direct application of self-etching sealant alone, no resin tag formation was observed rather, huge gaps existed in all the samples in the resin tooth interface. i.e., the self etching sealant was not able to form bond to enamel surface. The gap formation might also be due to the polymerization contraction which occurs towards the light source. The shallower etching pattern and reduced micromechanical retention has been reported to be a concern with mild self etching systems especially when bonding to unprepared enamel perhaps jeopardizing the strength of the resin enamel interface.[16] Studies have also shown that bonding to the ground versus unprepared enamel yields similar bond strengths of self etching systems.[17] Since the evidence in the subject remains controversial, manufacturers often recommend a preliminary phosphoric acid etching step prior to the application of mild self etching systems to improve the bond strength to enamel.[18,19]

Similar to the results from previous studies, which have demonstrated the beneficial effects of enamel etching with phosphoric acid.[20,21] Present study results also found significantly improved enamel bonding for surfaces pre-etched with phosphoric acid. For Group A mean resin tag length of 18.98 microns was found. It could be due to greater depth of demineralization with increased penetration of resin, resulting in longer tags. Phosphoric acid pre- etching removes the outermost enamel and creates micro irregularities, with adherent surface, resulting in higher bond strength values.[22,23]

CONCLUSION

Findings of the present study suggest that PF SEAL SE is a material that does not exhibit any efficient bonding and penetration to the tooth surface. If we apply the material following manufacturer's instructions, there will be increased micro leakage and chances of failure of the restorations are more. Findings also suggest that the penetration capacity (resin tags) of the self-etching sealant might be improved by previous acid etching of the dental enamel. This is clinically relevant, as retention is fundamental for those restorative procedures that mainly dependent on dental enamel. Therefore, utilization of previous acid etching or removal of prismatic enamel layers either by grinding or by preparation of a bevel on the cavity margins, may result in superior retention.

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