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Comparative evaluation of the length of resin tags of three different types of pit and fissure sealants-An *In vitro* scanning electron microscopic study

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Abstract

Introduction: Dental caries is a global concern which harness the health and quality of life affected by it. Use of fluorides and pit and fissure sealants are available in the modern era for the prevention of dental caries. The rationale of pit and fissure sealant is that when they are applied to caries prone fissures, it should penetrate deep and create marginal seal.

AIMS: This study aims to comparatively evaluate the resin tag lengths of three types of Pit and fissure sealant.

Materials and Methods: 30 premolar teeth divided into 3 groups. Group A: Helioseal clear, Group B: Biocoat and Group C: Beautisealant. Teeth are cleaned with pumice prophylaxis, pretreated with acid etching and respective pit and fissure sealant is applied. Teeth samples are thermocycled, sectioned longitudinally in mesiodistal direction and prepared for the evaluation of scanning electron microscopy.

Result: Resin tag length were found to be longer in Biocoat followed by Helioseal clear and shorter for Beautisealant.

Conclusion: Bioactive Biocoat bonded by micromechanical adhesion on acid etched enamel surface is used as biocompatible pit and fissure sealant offering longer resin tag length, more retention and better cariostatic properties.

Keywords: dental caries, pit and fissure sealant, resin tag length, thermocycling, scanning electron microscopy

Introduction

Dental caries is a microbiological disease that progresses when bacterial action produces acid on dietary carbohydrate fermentation which diffuses in the tooth and cause demineralisation. During the period of tooth eruption, the physiological cleaning mechanism by tongue, lips and cheeks during chewing and swallowing are absent. Inefficient cleaning can affect the surfaces of the erupting teeth, clogging the pits and fissures with deposits of bacterial fermentation products producing biofilm and starts the process of demineralisation. According to Williams, a fissure sealant is "a substance that is placed in the pit and fissure pattern of the teeth such that it prevents the ingress of plaque, bacteria and carbohydrate and in so doing prevents the onset of caries at those sites [1]. Thus the sealant not only prevents tooth decay before it initiates, but also arrests its progress. The action relies on ability of sealant to fill the fissure and not detach. Retention is provided by resin tags that form an effective mechanical interlock between resin material and enamel surface [2]. This study aims in comparing and evaluating the resin tag lengths of different types of pit and fissure sealants.

Materials and Methods Materials

Sample: 30 extracted premolars.

Inclusion Criteria

Teeth with intact pit and fissure on occlusal surface.

Exclusion Criteria

Teeth with occlusal caries, cracks, restorations, and developmental anomalies.

Test Materials

1. Conventional resin-based sealant (Helioseal clear, 3M ESPE Co. Ltd.)
2. Bioactive resin-based sealant (Biocoat, Premier Co. Ltd.)
3. Fluoride containing sealant (Beautisealant, Shofu Co. Ltd.)

Equipment

1. Thermocycler (Wileytec Thermocycler, Haake Ek 30)
2. Micromotor diamond disc (BUELER ISOMET 50000)

Scanning electron microscope (IISc BANGALORE)

Fig 1: Tooth specimens

Fig 2: Test materials used in the study a) Helioseal clear b) Biocoat and c) Beautisealant

Fig 3: a) Sectioned samples mounted on aluminium stubs b) Geo gold sputter coater c) Scanning electron microscopy.

Methodology

Collection and Preparation of Samples

30 extracted maxillary first premolars satisfying the inclusion criteria were collected from the Department of Oral and Maxillofacial Surgery, Mar Baselios Dental College. All the teeth were cleaned with periodontal scaler and curette and stored in distilled water. The occlusal surfaces were cleaned with pumice slurry using a short bristle brush and washed thoroughly with water spray. A sharp explorer tip was then run through all pits and fissures to remove pumice.

The collected samples are grouped in to 3 groups with ten in each.

- Group A: Conventional resin-based sealant.
- Group B: Bioactive resin-based sealant.
- Group C: Fluoride releasing sealant.

Each tooth was sectioned longitudinally in a mesiodistal direction through the centre of the sealant with a diamond wheel measuring 0.02 mm in thickness. The root portion of the teeth was then cut and removed. Half the section of each tooth was used for evaluating the resin tag lengths. The tooth sections were subjected to polishing using a carbide stone. The polished sections were then undergone decalcification using 37% phosphoric acid for 15 seconds to etch away any enamel inorganic component not protected by sealants and then rinsed and stored in distilled water.

The tooth sections were dried thoroughly under the heat lamp, and then mounted on brass rings using a non-conductor tape made of carbon.

These mountings were then placed inside an ion spluttering device for 30 minutes using vacuum evaporation at 200 -300 Aº. The gold spluttered sections were then placed inside the scanning electron microscope of 20 kV capacity and images of the sections were obtained. The SEM images were then analysed by image J software to determine the resin tag length.

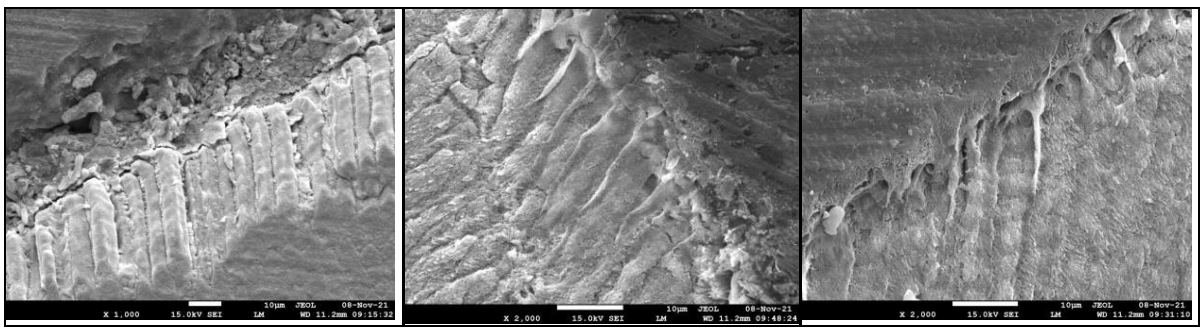


Fig 4: SEM images of a. Helioseal clear, b. Biocoat and c. Beautisealant.

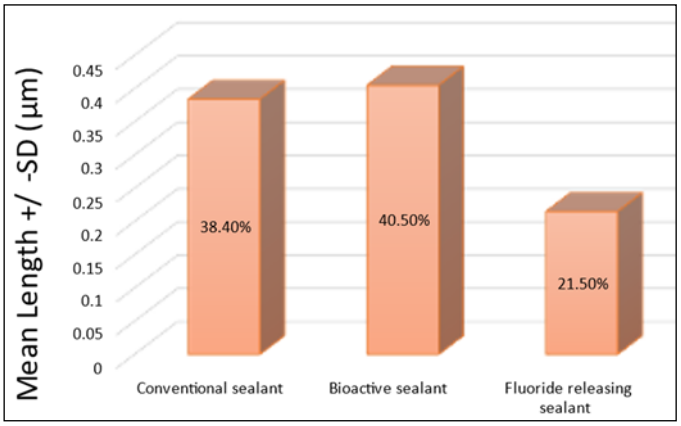
Results

The recorded values were represented as mean ± standard deviation and range values, and were statistically analyzed using one way analysis of variance (ANOVA) for intergroup comparison.

Table 1 and Graph 1 show the comparison of values obtained for resin tag length between group A, group B and group C. The mean resin tag length for Group A is11.365±4.28; for group B is 12.99±4.84 and for group C is 8.496±1.85. The mean difference of group A v/s group B is 4.28, group B v/s group C is 0.49 and group A v/s group C is 3.79. No statistically significant differences were found between group A v/s group B and group A v/s group C. Statistically significant difference ($p < 0.05$) was seen between group B v/s C. The mean resin tag length was highest for group B.

Table 1: Mean difference of resin tag lengths and intergroup comparison of the resin tag length between Group A, Group B and Group C.

Type of pit and fissure sealant	Mean Length +/- SD (µm)	Percentage	Groups compared	Mean difference	p value	SIGNIFICANCE
Conventional Sealant	11.365±4.28	38.4%	A/B	4.28	0.95	NS
Bioactive sealant	12.99±4.84	40.5%	B/C	0.49	<0.05	S
Fluoride releasing sealant	8.496±1.85	21.5%	A/C	3.79	0.09	NS



Graph 1: Showing the mean resin tag lengths and intergroup comparison of the resin tag length of the three groups in the study.

Discussion

Dental caries is a multifactorial disease caused by alteration in the composition of the microbial biofilm, giving rise to a disparity in the demineralization and remineralization cycles and exhibited by the formation of caries lesions in primary and permanent dentitions [1]. Pit and fissure caries accounts for about 90% of the caries of permanent posterior teeth and 44% of caries in the primary teeth in children and adolescents [3]. Occlusal pits and fissures vary in shape, but are generally narrow (~ 0.1 mm wide) and tortuous, and are considered to be a suitable niche for retention of food remnants and bacterial products. This is because the morphology renders the mechanical means of debridement inaccessible as an average tooth brush bristle (0.2 mm) is too large to penetrate most of the fissures [2].

The sense of need for clogging susceptible spots on tooth, which could trap foods and dental plaque and subsequently develop caries has a long history in dentistry [5]. Older methods to prevent caries in the pits and fissures include mechanical fissure eradication, prophylactic odontotomy, chemical treatment with silver nitrate and sealing with zinc phosphate cement, but not in use nowadays [4]. Currently used effective measures like use of pit and fissure sealants accomplish its preventive effects by mechanically filling the fissures with acid-resistant resin, make Streptococcus mutans and other caries-related microorganisms get deprived of their habitat because of fissure blockage by resin and there by facilitate the cleaning of pits and fissures by leaving an even surface in occlusal area [5, 6].

A recent update of a Cochrane review has concluded that there is only a little evidence suggestive of superior performance of pit and fissure sealants, when compared to fluoride varnish application, to prevent the occlusal caries. According to Ahovuo-Saloranta *et al.* resin- based sealants have clear advantage over fluoridation, whereas no significant difference could be found between glass ionomer sealing and fluoridation [7].

A recent meta-analysis investigated and reported that the clinical retention rates of pit and fissure sealants with regard to different types of materials at different observation-times. The resin-based sealants showed the best retention rates: the five-year retention rates for light-polymerizing, auto- polymerizing, and fluoride-releasing resin-based sealants were 83.8%, 64.7%, and 69.9%, respectively [8].

Studies by Blackwood *et al.* showed that among enameloplasty, air abrasion and pumice prophylaxis, conventional pumice prophylaxis showed the least microleakage [11]. Fewer studies show that pumice prophylaxis does not completely and consistently remove the pellicle and debris, especially in the deep fissures. In the present study, despite of all the arguments, conventional pumice method was used for prophylaxis before etching [12].

A sealant is effective in controlling the onset and progress of caries only when it is possible to retain it in the fissures. Hence the retention is a major concern which influences efficacy of sealant material. The retention in resin-based pit and fissure sealant is offered by the micromechanical adhesion between the enamel and the resin. Penetration of sealant in to the porous enamel forming tags forms the basis of mechanical retention. This occurs by capillary action. Monomer in the material polymerizes and the material becomes interlocked with the enamel surface [13].

In the present study, the resin tag lengths of an S-PRG filler-containing sealant bonded by self-etching primer and of one conventional and bioactive resin-based sealants bonded by acid etching on enamel subsurface lesions were compared. Comparing the application of either phosphoric acid or self-etching primers to intact enamel

showed that self-etching primers demineralized the enamel insufficiently and resulted in shallower adhesive penetration, shorter resin tags as well as lower bond strength which was supported by the study by Kanemura *et al.* 1999 [14].

Incoporation of fluoride to a sealant have additional caries protection. Higher levels of fluoride is released initially with salivary fluoride concentration being peak with in 30 min after sealant application. The fluoride concentration drops to baseline with in 1-2 days after sealant placement [20]. Evaluation of the combined use of fluoride and dental sealants has showed retention of 92% after 4 years. This suggests that pit and fissure sealants confer additional caries preventive benefits when compared to fluoride therapy. This supports my present study that the bioactive resin based pit and fissure sealant shows better cariostatic action than conventional resin based pit and fissure sealant and fluoride releasing non resin based pit and fissure sealant.

In the present study the mean length of tags obtained was in the range of 15 µm to 5 µm. Other studies by Gomez *et al*. and Karina Tonini *et al*. have also concurred with the measurements obtained [15, 16]. Different pretreatments seemed to have an impact on the penetration depth of the sealant material in to the fissures [19]. In the present study, the use of bioactive resin based sealant showed longer resin tag length (12.9 µm), then the conventional resin based sealant (11.36 µm) and shorter for the fluoride releasing sealant (8.49 µm). This is explained by the difference in the contact angle of the occlusal surfaces after the application of different acids/primers, thus altering the ability of the sealant to flow and spread in to the fissure [19].

The phenomenon of closed end capillaries or isolated capillaries made the complete penetration of sealant in to complex fissure system difficult. Some lateral fissures arising from the main fissures also fail to be filled with sealant [17]. Hence, further research on the effect of fissure morphology on sealant microleakage and penetration are necessary. The SEM can produce images of high resolution and revealing details of size less than 1 to 5 nm and thus helps in measuring the length of resin tag length. SEM micrographs have a greater depth of field providing a characteristic three- dimensional appearance of images due to narrow electron beam [18].

Depending on the environment, all pit and fissure sealants may act variably due to other attributes like type of fissures, preparation of fissures, enamel etching and conditioning, application of bonding agent and contamination of prepared surfaces of fissures [2]. Appropriate method of application of sealants and viscosity of the sealant also influences the depth of penetration and retention and thereby preventing the microleakage and thus improving the efficiency of the sealant in preventing caries.

Conclusion

Longer resin tag length offers better retention of the pit and fissure sealant and better will be cariostatic action of the sealant by preventing the microleakage thereby. Bioactive resin based sealant forms longer resin tag length followed by conventional resin based pit and fissure sealant, attributed by micromechanical mode of adhesion on acid etched enamel surface. Fluoride releasing pit and fissure sealant containing surface reaction type pre-reacted glass ionomer filler bonded by self-etching primer shows shorter resin tag length.

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