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Original Research

Comparative evaluation of Shear bond strength of different Pit and fissure Sealants in Primary and Permanent teeth - An In-Vitro Study

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Abstract:

Background: Dental caries among children is one of the greatest challenges faced by dentists globally; especially that of susceptible surfaces like the Pit and fissures. Dental sealants have proved to be an effective way to prevent caries development. The Clinical success of any material depends upon its adhesion to tooth structure, resistance to wear and ability to withstand the masticatory or occlusal forces. Hence it is important to evaluate the shear bond strength (SBS). The Present study's aim was to evaluate and compare the shear bond strength of different pit and fissure sealants placed on Primary molars and Permanent Premolars.

Materials & Methods: Sixty noncarious extracted teeth comprising of thirty Primary molars and thirty Permanent Premolars were divided into four groups of 15 each. The buccal surfaces of all teeth were dried, etched and the etched surfaces of Primary molars (Group I) and Permanent Premolars (Group III) were placed with Helioseal-F while Groups II and IV, that included Primary molars and Permanent Premolars received Clinpro. Shear bond strength was evaluated and the mean was obtained for all the groups. The results were analyzed using two-way analysis of variance followed by Tukeys post hoc procedure to check for significant differences.

Results: The specimens of unfilled sealant Clinpro (Groups II & IV) showed higher Shear bond strength when compared to the specimens of filled sealant Helioseal-F (Groups I & III).

Conclusion: The unfilled sealant showed a better Shear bond strength compared to the filled sealant. The bond strength in Primary molars was slightly higher compared to Permanent Premolars.

Key Words: Etchant, pit and fissure sealants, shear bond strength

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 the development of occlusal caries.[1] The occlusal surface of the first permanent molar is the tooth surface most vulnerable to dental decay.[2] The complex morphology of occlusal pits and fissures makes them an ideal site for retention of bacteria and food remnants, making it almost impossible to maintain hygiene. 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.[3] The plaque accumulation and caries susceptibility are greatest during the eruption of molars and caries susceptible individuals are therefore vulnerable to early initiation and fast progression of caries in these sites.[4] Although fluoride has been used in the prevention of caries, it is more effective on smooth surfaces. Fluoride can only delay the onset of caries in pits and fissures, but will not prevent it.[5] Hence, in the recent years there is more emphasis on the use of Pit and fissure sealants that bonds to enamel and there are various commercially available materials for the same.

With the introduction of acid etching by Buonocore in 1955, bonding of resin material was possible to tooth structure and a further step in its use was the prevention of

pit and fissure decay. Thus, resin sealant methods came into existance.[6] This resin continues to form the basis of presently available sealants.[7] In order to improve the properties of sealants, manufacturers have added filler particles, fluoride and colour to the resin material. Sealants can be filled or unfilled. Filled sealant contains silane treated amorphous silica as a filler particle of size 0.016 micrometers, and one such sealant that is recently introduced is Helioseal-F. Sealants also can be either clear or coloured. Coloured sealants have an advantage as their presence or absence on the tooth surface can be easily seen. One such Sealant that changes colour during polymerization is Clinpro 3M ESPE.[8]

A pit and fissure sealant is a resin material that is introduced into the pits and fissures of caries-susceptible teeth, forming a micromechanically retained physically protective layer that acts to prevent demineralization of enamel by blocking the interaction of cariogenic bacteria and their nutrient substrates, thus eliminating the harmful acidic by-products.[9] The properties required for an ideal fissure sealant include biocompatibility, anticariogenicity, adequate bond strength, good marginal integrity, resistance to abrasion and wear, and cost effectiveness.[10]

The placement of sealants and their continued maintenance are scientifically sound and cost effective techniques, for preventing pit and fissure caries in children. As long as the sealant remains intact, caries should not develop beneath it.[11] Thus retention rates are of interest as sealants effectiveness is directly related to its retention and completely sealed fissures should not develop caries.[12]

One of the prerequisites for a sealant to be effective as suggested by Brauer is that it should have good and prolonged adhesion to enamel.[13] This necessitates the need to evaluate bond strength. Laboratory in-vitro tests play a very important role in providing the necessary information regarding the efficacy of new products in a short period of time. Hence the present in-vitro study was designed to evaluate and compare the shear bond strength of different pit and fissure sealants applied to the enamel on buccal surface of Primary molars and Permanent Premolars.

Materials and Methods

Sealants used were filled fluoride releasing Helioseal-F (Ivoclar-Vivadent) and Unfilled fluoride releasing Clinpro (3M ESPE) (Figure 1).

Figure 1: Pit and fissure sealants and Etchant.

Sampling for shear bond strength evaluation

Thirty human maxillary or mandibular Premolars extracted for orthodontic purpose and thirty Primary maxillary or mandibular caries free molars with preshedding mobility and indicated for extraction were included in the study.

Teeth were cleaned with ultrasonic scaler to remove tissue tags and plaque and were polished with pumice and stored in distilled water at 37^{0}C for a maximum period of six months.[14]

Materials were assigned to each group as follows:(Table 1)

Table 1: Size and Sealants.

Group	Sample Size	Material	Surface Treatment
I	15	Helioseal-F (Ivoclar - Vivadent)	Primary molars
II	15	Clinpro (3M ESPE)	Primary molars
III	15	Helioseal-F (Ivoclar - Vivadent)	Permanent Premolars
IV	15	Clinpro (3M ESPE)	Permanent Premolars

The buccal surfaces of each tooth were cleaned with prophy paste, and then polished with silicon carbide paper to obtain a flat enamel surface. For all the specimens, 37 % phosphoric acid etchant was applied to the enamel for 20 seconds, rinsed and dried with air spray for 20 seconds. A teflon mold 3mm in diameter and 3mm in height was placed over each tooth perpendicular to the polished surfaces (Figure 2). The enamel surfaces were divided into three parts, and middle segment was used to standardize the bonding of specimens.[15] The test materials were placed in the mold in an incremental fashion to form a button and

Figure 2: Teflon mold.

Figure 3: Color coded tooth samples mounted on acrylic blocks.

cured according to manufacturer's instructions.[16] Once the materials were light cured, the specimens were stored in distilled water at 37^{0}C for 24 hours to avoid dehydration.[15] Then the specimens were embedded in polyester resin using polyvinyl chloride rings (3.2 cm diameter and 1.5 cm height).[17] These mounted specimens were color coded according to the groups assigned before evaluating the Shear bond strength (Figure 3).

Universal Instron testing machine (Unitek, 9450 PC, FIE, INDIA) (Figure 4) was used wherein the treated surface of the specimens were held parallel to the shearing rod at a crosshead speed of 0.5 mm/minute (Figure 5).[15] The results were recorded in Megapascals (MPa). The results were subjected to statistical analysis using two-way analysis of variance (ANOVA) followed by Tukeys post hoc procedure to check for any significant differences.

Results

The results and observations of shear bond strength are summarized in Tables 2 – 5.

A comparison of shear bond strength of two Pit and fissure sealants showed a statistically significant difference, where Shear bond strength of Helioseal-F was found to be lesser as compared to Clinpro and shear bond strength among primary and permanent teeth was statistically insignificant, as Shear bond strength in Primary molars was found to be slightly higher as compared to Premolars. The shear bond strength according to interactions of Pit and fissure sealants and teeth showed statistically significant difference between Primary molars of Clinpro as compared to minimum mean bond strength in Primary molars of Helioseal-F as compared to others. The comparison of Two-way ANOVA with interaction effect of materials and teeth with respect to Shear bond strength showed that the

Figure 4: Universal Instron testing machine.

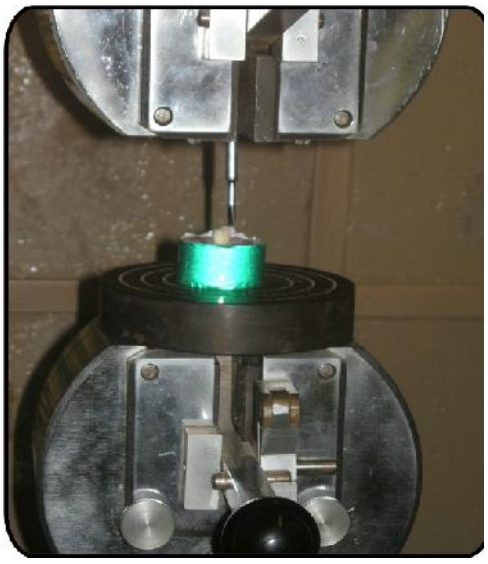

Figure 5: Testing of shear bond strength.

Table 2: Mean and SD of SBS according to Sealants.		
Sealants	**Mean(MPa)**	**±SD**
Helioseal-F	13.07	±3.78
Clinpro	24.73	±9.98

Table 3: Mean and SD of SBS according to Teeth.		
Teeth	**Mean(MPa)**	**±SD**
Primary molars	19.29	±10.64
Premolars	18.51	±8.40

main effect of Sealants (Helioseal-F and Clinpro) on Shear bond strength was found to be significant at 5% level of significance and the main effect of teeth (Primary molars and Premolars) on bond strength was not found to be significant at 5% level of significance.

Table 4: Mean and SD of SBS according to interactions of Sealants and teeth.		
Sealants & Teeth	**Mean(MPa)**	**±SD**
Helioseal-F & Primary molars	10.99	±3.12
Clinpro & Primary molars	27.60	±8.78
Helioseal-F & Premolars	15.15	±3.24
Clinpro & Premolars	21.87	±10.56

Table 5: Two-way ANOVA with interaction effect of Sealants and teeth with respect to Shear bond strength.					
Source of variation	**Degrees of freedom**	**Sum of squares**	**Mean sum of squares**	**F-value**	**P-value**
Main effects					
Sealants	1	2039.4806	2039.4806	39.0381	0.0000*
Teeth	1	9.1894	9.1894	0.1759	0.6765
2-way interaction effects					
Sealants & Teeth	1	366.9630	366.9630	7.0241	0.0104*
Error	56	2925.6238	52.2433		

***p<0.05**

Discussion

Pit and fissure sealants have become the most effective non invasive treatment to prevent or arrest occlusal caries.[18] The occlusal surface is at high risk for caries.[19] This is especially true for newly erupted molars, where anatomic characteristics cause difficulty in access for cleaning procedures and incomplete maturation of enamel adds to caries susceptibility. The complex morphology of the occlusal surface also reduces the effectiveness of fluoride in the remineralizing phases.[20] The rationale for the use of sealants as a preventive intervention is the high prevalence of pit and fissure caries regardless of the action of fluoride protection, since the pit and fissure surfaces are less protected than smooth surfaces by the fluoride.[21]

The first clinical study on sealant retention was by Cueto and Buonocore in 1967. They found an 86.3% reduction in caries one year after application of sealant. The efficiency of sealants in preventing caries has been associated with the duration and degree of sealant retention.[22]

The caries preventive property of sealant is based on the establishment of a seal which prevents leakage of nutrients to the micro flora in the deeper parts of the fissure. The preventive effects of a sealant are maintained only as long as they remain completely intact and bonded in place.[23]

Adequate retention of sealant requires the sealed tooth to have a maximum surface area with deep, irregular pits and fissures, and to be clean and dry at the time the sealant material is placed.[24]

Moreover the Clinical durability of the material also depends upon the type of sealant used. So the present in-vitro study was conducted with the objective to evaluate and Compare the Shear bond strength of two Pit and fissure sealants on both Primary molars and Premolars.

Sealants employed in the Present study included both filled and unfilled type. Resin sealants posses both low viscosity and excellent wetting properties as found in unfilled.[25] For a liquid to flow over a solid, the surface tension of the solid must be greater than the surface tension of the liquid. Less viscous sealants present better flow and thus get penetrated more deeply into the fissures. For this reason, a filled sealant would be less prone to completely fill a fissure than an unfilled material. The

difference in chemical composition of the monomeric matrix causes difference in flow properties of the final polymers in filled sealants. Urethane monomer may confer more elasticity and adhesiveness to the resin than does the Bis-GMA monomer.[26] This is in accordance with our study where enamel adhesion was found to be superior with the unfilled sealant (Clinpro) that has also got low viscosity.

Sealants are indicated in both Primary as well as in Permanent teeth. Primary teeth may also be judged to be at risk due to fissure anatomy and/or patients caries risk factors. This is also true for Permanent teeth other than molars. Any teeth judged to be at risk can certainly benefit from sealant application. Teeth in the Present study included both Primary as well as Permanent in order to evaluate the interaction in both. The notion that Primary tooth enamel does not etch well and was, therefore, difficult to bond has been proved otherwise by the long and successful experience of dentists using acid etching on Primary enamel and it has been found successful in Primary as well as in Permanent teeth. Clinical study reports on sealant success when applied to Primary molars are rare. Those that have been published reported retention and success of sealants was equivalent to Permanent molars.[27] In our Present study, we found out that Shear bond strength to Primary enamel was slightly higher (19.29) than Permanent teeth (18.51).

Bond strength was considered to be checked as it is a representative of the clinical situation. For Bond strength evaluation, all the specimens were stored in distilled water before and during the study period as it does not affect the permeability and bond strength, as compared to saline. The buccal surfaces of all teeth were considered as this surface allowed the shearing force to be exactly perpendicular to the bonded specimen.[16]

Pit and fissure sealants are a major cornerstone in preventive dentistry.[28] Hence, further clinical studies are required to assess retention to Primary and Permanent teeth and caries prevention of filled and unfilled sealants. The present investigation was an in vitro study and the results may not necessarily be the same as those that would be obtained in the oral environment. Therefore, more research is needed to prove the clinical reliability of newer products.

Conclusion

Following conclusions were drawn from the study:

The Bond strength of the unfilled resin sealant was found to be superior to that of the filled resin sealant and the bond strength was higher in Primary molars and Premolars of Clinpro as compared to Primary molars and Premolars of Helioseal-F. Since this is an *in-vitro* study, the clinical significance of these findings can only be determined with further studies assessing the clinical retention of various sealants to Primary and Permanent teeth.

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