An evaluation of the bond strengths to enamel of two fissure sealants

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The objective of this study was to carry out a comparative evaluation of the bond strength to enamel of two present-day fissure sealants, Helioseal® and Concise®; good adhesion of the material to the tooth surface is one of the requisites for the success of this preventive technique. To this end, 16 caries-free human premolars extracted for orthodontic reasons were used. Proximal, mesial, and distal surfaces were treated and studied. Bond strength was evaluated by the application of compression forces (Instron®) at a velocity of 0.5 mm/mm. The overall results obtained do not show significant differences between the two materials.

J Clin Pediatr Dent 24(4): 287-290, 2000

INTRODUCTION

The prevalence of clinically detectable dental caries has diminished considerably over the past twenty years, particularly in developed countries. This is largely due to the development and spread of preventive dentistry. There has been a notable fall in the number of interproximal lesions whilst the occlusal surfaces have continued to be the most susceptible to this disease.[1,2] Occlusal caries remains a problem: two thirds of all caries are located in this surface area.[3] Furthermore, the preventive and protective action of fluoride is less at this level than on flat or interproximal tooth surfaces.[2,3] Consequently, the utilization of a physical barrier, which isolates the occlusal surfaces from the buccal surrounds in order to impede the onset of caries, has a valid scientific foundation.[4]

The joint use of fissure sealants and topical fluorides may have complementary benefits in the field of prevention: the sealants give protection against occlusal caries whilst the fluorides provide protection particularly to the other tooth surfaces. Together with plaque control and dietary control, this leads to integrated preventive attention.[5,6]

As regards sealants, a variety of materials has been utilized since their introduction in the 1960s: cyanoacrylates, polycarboxylates, polyurethanes, BIS GMA.[7-9] These have undergone divers modifications and application techniques for their use have also changed.[10] The efficacy of correctly-applied fissure sealants in the prevention of caries has been demonstrated, and the use has increased over recent years both in individuals and in community programs.[11]

Among the qualities required of a good sealant are biocompatibility, retention capacity, and resistance to wear/abrasion. Two important aspects of this technique are bond strength and the penetration of the sealant into the occlusal fissures previously etched to increase the bonding of the sealant resin to the tooth surface. The degree of penetration will also be affected by the geometric configuration of the fissure, deposits of material in the fissure, and the physio-chemical characteristics of the sealant resin.

At the present time, the materials of choice are resins of the BIS GMA type, with or without filler,[13] as, in spite of the interest in the utilization of glass ionomers as sealant materials as an alternative to sealant resins because of their adhesive capacity and their slow release of fluoride, recent clinical studies suggest 'that the retention capacity of glass ionomers is significantly less than that of the resins and do not recommend them as sealant material.[14]

The objective of the present study is to make a comparative evaluation of the shear bond strength to previously etched enamel of two light-curable sealants, one with and one without filler: Concise® (3M) and Helioseal® (Vivadent).

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MATERIALS AND METHODS

For this experimental study we used 20 caries-free human premolars, extracted for orthodontic reasons and stored in distilled water. Proximal, mesial, and distal surfaces were addressed. Materials used were Helioseal® (Ivoclar Vivadent Schan. North America, Inc. Liechtenstein), Concise Light Cure White Sealant® (3M Dental Products Division Laboratory, MN, USA) and 37 percent phosphoric acid in gel form (Email Preparator GS®, Vivadent, Liechtenstein).

The 20 teeth were separated into two groups of ten (20 surfaces per group):

Group 1: Etched enamel. Helioseal®.

Group 2: Etched enamel. Concise®.

The procedure was as follows: The mesial and distal surfaces of the teeth were polished with medium-and fine-grit silicon carbide paper in order to obtain flat enamel surfaces. The enamel was then etched with 37 percent phosphoric acid gel for twenty seconds, the gel was removed by a twenty-second application of distilled water and the surfaces were dried.

The sealants were managed and the tooth surfaces prepared strictly in accordance with the instructions of the manufacturers. A plastic ring (surface area l0.74mm^2) was placed over each tooth, perpendicular to the polished surfaces, and the appropriate material was introduced. All excess material was removed from around the edges.

Polymerization of the material was carried out by application of light (Optilux 400 TM) for forty seconds (a twenty-second exposure from each side of the ring)

Once the material was light-cured, the specimens were stored in distilled water at room temperature for twenty-four hours, in order to avoid dehydration. They were then mounted in dental stone with the treated surfaces parallel to the shearing rod of the testing machine (Autograph AGS Instron® Corp, Shimadzu, Kyoto, Japan). They were sheared at a crosshead speed of 0.5 mm/minute and the results were recorded in Megapascals (MPa).

For the statistical treatment which would enable us to evaluate the results, an analysis of variance of repeated measurements with two grouping factors (material and surface) was performed.

RESULTS

Table 1 shows the shear bond strength results obtained for each material. Individually, the most disparate values were obtained in specimens where Helioseal® was used (8.98 and 2.06 MIPa). Mean values for strengths of adhesion depending on material and surface are listed in Table 2. The highest value for adhesion was seen using Concise® on mesial surfaces (5.55 MIPa), and Helioseal® showed the lowest value for adhesion on distal surfaces (4.87 MIPa). We did not find any statistically significant differences between tooth surfaces.

In the analysis of variance of repeated measurements performed in order to evaluate the effect of the different materials on the different surfaces we again found no significant differences between materials or surfaces. We concluded that surface is not an influential factor.

DISCUSSION

These materials, resins based on BIS GMA or urethanes, are chemico-organic compounds and are employed to cover the irregular surfaces of the teeth, after acid etching, thereby forming a physical barrier, which impedes the onset of caries in these areas.

The principal objective is to obtain good adhesion of the materials to the enamel surface. Our intention here was to evaluate the shear bond strengths of the sealants to previously etched enamel surfaces. We used two types of sealants, one with and one without microfiller, one of urethane type composition (Helioseal® Vivadent) and one of BIS GMA type with 5 percent amorphous silica (Concise® 3M). The study done by McCourt[15] found that sealants without filler provided greater penetration into enamel, especially into fissures, than sealants incorporating a microfiller. Rock *et al*.[16] were of the same opinion: in the evaluation of the retention capacities of sealants with and without filler, the sealant without filler showed significantly better results after three years.

However, other authors[17-19] have not found significant differences in either retention or bond strength between sealants with and without filler and have found that both penetrate into fissures equally well. The results of the present study do not show any statistically significant differences of bond strength between the two materials. On comparing our work with the results obtained in a previous study using similar techniques,[20] we observed that the adhesion values for Helioseal® found in that study were higher than those obtained by us (14.00 and 5.00 MPa respectively). Two factors that may have had repercussions here are the small number of specimens, both in the present study (ten teeth, 20 surfaces treated) and in the aforementioned study (ten teeth), and the difference in the velocity of application of forces (0.5 mm/mm vs 1.00 mm/mm).

Table 1. Shear bond strength to enamel of each material (MPa)

	Mean	Range
Heioseal	4.917	(2.06-8.98)
Concise	5.265	(2.46-7.91)

Table 2. Shear bond strength depending on material and surface (MPa)

	Helioseal X	Helioseal SE	P	Concise X	Concise SE
Mesial	4.963	±0.455	NS	5.558	±0.514
Distal	4.872	±0.745	NS	4.913	±0.495

mean P level of significance
SE= Standard Error NS= Non significant

Table 3. Analysis of variance of repeated measurements

Source	Sum of squares	DF	Mean square	F	P
MATERIAL (M)	-0.96953	1	0.96953	0.27	0.6117
SURFACE (S)	0.91463	1	0.91463	0.61	0.4470
SxM	0.48758	1	0.48758	0.33	0.5768

DF Degrees of freedom P= Level of significance

As regards the procedure utilized in the resin application technique, we followed the steps first suggested by Buonocore[21] in order to achieve the greatest resin-enamel union. The same technique was used in both groups. For the acid-etching, though several materials are used to this end (e.g. citric acid, 35 percent polyacrylic acid),[22] we chose to employ the one in most frequent use, 37 percent orthophosphoric acid in gel form, because it is easy to apply and control[23] and there are no significant differences in comparison with the liquid form.

Etching time was twenty seconds as the retention percentage of sealants applied after a twenty second etching is the same as after a sixty second etching, there is no loss of bond strength, and the work-time is less, according to the study by Eidelman *et al*.[24]

With regard to the selection of materials, we chose to use two photopolymerizable sealants as numerous studies have compared the bond strength[25] and the retention percentages[6] of autopolymerizable and photopolymerizable sealants and have pointed out that these offer similar results. Time spent on the work is less and is controlled by the operator, and the formation of bubbles is also less.

Polymerization time was 40 seconds, in accordance with the recommendations in the study by Garcia Godoy *et al*.[17] where polymerization time was 0 or 60 seconds. These authors state that with an increase in polymerization time greater bond strength is produced, and resistance to the forces of abrasion and to the wear and tear caused by mastication is increased.

In the present study, in contrast to that of Marcushamer *et al*.[20] specimens were not subjected to thermocycling as present-day methods are severe and might well exceed the different temperatures to which teeth are exposed during the process of alimentary ingestion.[26]

Without doubt, further studies will be carried out in order to determine the cohesion of the materials, as well as their adhesion, and other physical properties of these compounds, fluoride content, etc. Nevertheless, at the moment results are encouraging and this inclines us to continue to use these materials in the field of modern preventive dentistry.

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