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In Vitro Evaluation Of The Enamel Shear Bond Strength Of A Resin And Ormocer Based Sealant, Pretreated With An Antibacterial, A Total Etch And A Self-etch Adhesive

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Abstract
AIM: To evaluate the in vitro enamel shear bond strength of a resin and an ormocer based sealant, pretreated with an antibacterial, a total etch and a self-etch adhesive.
Methodology: Forty extracted human mandibular molars were taken. The teeth were sectioned bucco-lingually into two halves (n=80) and then embedded in methyl methacrylate blocks with proximal surface parallel to the horizontal plane. The samples were cleaned using pumice slurry and a rubber cup and ground to a flat surface with an extra fine diamond bur. The samples were divided into five groups with 16 sections each, depending on the bonding agent applied. . The five groups consisted of Single Bond, Clearfil Protect Bond, Clearfil SE Bond, Admira Bond and lastly the control with no bonding agent application. Each group was further subdivided into two (A& B) with 8 samples each according to the two sealants used (Admira Seal and Clinpro Sealant). The sealants were filled with the help of a polymeric cylindrical mold 4mm in Height and 4mm in diameter placed on the bonded surfaces. The samples were then mounted on a Universal testing machine for shear bond strength evaluation. The debonded specimens were examined using a 6x magnifying glass for the type of failure and the data was statistically analyzed.
Results: Single Bond with Admira Seal showed the highest shear bond strength values followed by Clearfil SE Bond, Clearfil Protect Bond, Admira Bond and lastly the control group. Examination of bond failure showed maximum amount of cohesive failure in Group I, II, mixed failures in group III, whereas Group VI and V showed more of adhesive failures.

Key Words
Shear Bond Strength, Sealants, Bonding Agents

Introduction

Pit and fissure sealants isolate the occlusal fissures from the oral surroundings and act as a physical and antibacterial barrier. These materials are either self cured or light cured glass ionomer sealants, filled or unfilled resin systems bonded to etched enamel. The key consideration to success of resin sealants is adequate penetration of the material into the etched surfaces. The use of bonding agents prior to a resin sealant on ground surfaces can yield greater bond strength than when using sealant alone.

Contemporary adhesives can be divided into two systems in terms of clinical application- Etch and rinse adhesives and the self-etch adhesives. The self-etching adhesives use hydrophilic, acidic monomers which are able to demineralize and penetrate enamel and dentin simultaneously. This system is a simplification of the bonding procedure and a potential decrease in technique sensitivity. With self-etching /priming systems in which the smear layer is not washed away, residual bacteria can be anticipated. Therefore, adhesive systems that possess antibacterial activity may contribute to better prognosis for minimal restorative treatments of dental caries.

Although a new restorativesystem exhibiting superior physical and mechanical properties hasOrmocer based Admira Bond (bonding agent) and Admira Seal (pit and fissure sealant), but still the bond strength of the etched enamel and sealants with an intermediate layer of a total-etch or self-etch bonding agent remains controversial.

Therefore the purpose of this in vitro study was to evaluate the enamel shear bond strength and the mode of bond failure of an unfilled resin and an ormocer based sealant after pre-treatment with an Ormocer based adhesive, a total etch , a conventional self-etch and an antibacterial self etch adhesive.

Materials And Methods

Forty extracted human mandibular molars were taken. The teeth were sectioned bucco-lingually into two halves (n=80) using a diamond disc and then embedded in methyl methacrylate blocks with proximal surface parallel to the horizontal plane. The samples were then cleaned using pumice slurry and a rubber cup and ground to a flat surface with an extra fine diamond bur (20-30µm grit). The samples were divided into five groups with 16 sections each, depending on the bonding agent applied. . The five groups consisted of Single Bond, Clearfil Protect Bond, Clearfil SE Bond, Admira Bond and lastly the control with no bonding agent application. Each group was further subdivided into two (A& B) with 8 samples each according to the two sealants used (Admira Seal and Clinpro Sealant).
The sealants were filled using a needle tip provided by the manufacturer with the help of a polymeric cylindrical mold

NPar Tests
Kruskal-Wallis Test **Ranks** ADMIRA SEAL ONEWAY

	GROUP	N	Mean Rank
SHEAR BOND STRENGTH	SINGLE BOND	8	30.13
	CLEARFIL PROTECT BOND	8	24.50
	CLEARFIL SE BOND	8	25.13
	ADMIRA BOND	8	18.25
	CONTROL (NO BONDING AGENT)	8	4.50
	Total	40	

Test Statistics[a,b]

	SHEAR BOND STRENGTH
Chi-Square	22.921
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: GROUP

Admira Seal Oneway

NPar Tests
Kruskal-Wallis Test **Ranks** CLINPRO SEAL ONEWAY

	GROUP	N	Mean Rank
SHEAR BOND STRENGTH	SINGLE BOND	8	27.06
	CLEARFIL PROTECT BOND	8	26.94
	CLEARFIL SE BOND	8	24.00
	ADMIRA BOND	8	20.00
	CONTROL (NO BONDING AGENT)	8	4.50
	Total	40	

Test Statistics[a,b]

	SHEAR BOND STRENGTH
Chi-Square	20.709
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: GROUP

Clinpro Sealant Oneway

4mm in Height and 4mm in diameter placed on the bonded surfaces. The samples were then mounted on a Universal testing machine for shear bond strength evaluation. The debonded specimens were then examined using a 6x magnifying glass for the type of failure. The data obtained was then statistically analyzed using SPSS software version 10 for windows with Oneway Anova, Post hoc, Kruskal Wallis and Mann-Whitney tests . The type of failure values were analyzed using Pearson-Chi square test.

Results

The results showed that Single Bond with Admira Seal showed the highest shear bond strength values followed by Clearfil SE Bond, Clearfil Protect Bond, Admira Bond and lastly the control group .There was no statistically significant difference amongst groups I, II and III. Group IV and V were statistically different from all the other groups. No statistical difference was obtained between the two sealants used. Examination of the bond failure showed maximum amount of cohesive failures in Group I, II, mixed failures in group III, whereas Group VI and V showed more of adhesive failures.

Discussion

Sealing of pit and fissures with low viscous materials such as dental adhesives and pit and fissure sealants could be an alternative approach to the widely used modalities of restorative treatment. The white spot lesion is characterized by a loss of mineral in enamel, whereas the surface of the lesion remains relatively intact. The tiny pores within the lesion act as a diffusion pathway for acids and minerals and therefore enable the dissolution of enamel at the advancing front of the lesion. The aim of the sealing regimen is to occlude these pores with low viscous materials by penetration into the lesion via the prism cores and fill the interprismatic areas.After curing, the fragile enamel also gets a mechanical support.The sealing prevents biofilm accumulation and migration of bacteria.
Effective sealing of the fissures is obtained through formation of a strong bond of the sealant to enamel. A good bond to enamel requires the standard clinical procedure of etching with phosphoric acid of cleaned enamel, rinsing with water spray, establishing of a dry field followed by application and curing of the sealant.

Various pretreatment methods have been investigated with the intention of enhancing the effectiveness of sealants. The use of air-polishing system was introduced in 1977, then the air abrasion system and nowadays the most widely accepted method is the usage of pumice slurry to clean the tooth.Therefore in this study the enamel surfaces were cleaned with pumice slurry and a rubber cup.

Enamel that is ground also provides a more receptive substrate for bonding.

Statistical analysis for Bond Failure

Crosstabs

GROUP * BOND FAILURE Crosstabulation

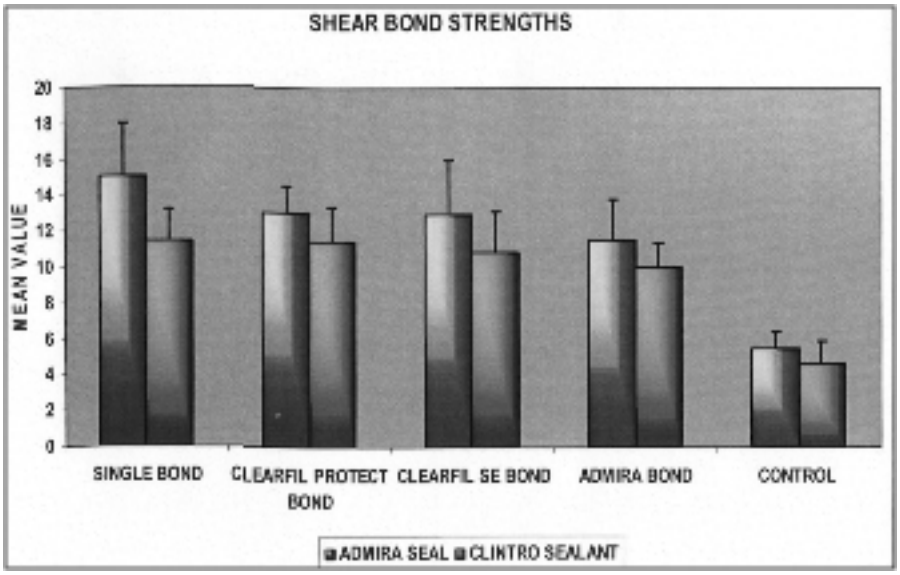
			BOND FAILURE				
			ADHESIVE	COHESIVE (IN ENAMEL)	COHESIVE (IN RESIN)	MIXED	Total
GROUP	SINGLE BOND	Count	3	4	2	3	12
		% within GROUP	25.0%	33.3%	16.7%	25.0%	100.0%
	CLEARFIL PROTECT BOND	Count	3	3	2	4	12
		% within GROUP	25.0%	25.0%	16.7%	33.3%	100.0%
	CLEARFIL SE BOND	Count	2	4	1	5	12
		% within GROUP	16.7%	33.3%	8.3%	41.7%	100.0%
	ADMIRA BOND	Count	5	2	2	3	12
		% within GROUP	41.7%	16.7%	16.7%	25.0%	100.0%
	CONTROL (NO BONDING AGENT)	Count	6		2	4	12
		% within GROUP	50.0%		16.7%	33.3%	100.0%
Total		Count	19	13	9	19	60
		% within GROUP	31.7%	21.7%	15.0%	31.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.331[a]	12	.759
Likelihood Ratio	10.762	12	.549
Linear-by-Linear Association	.195	1	.659
N of Valid Cases	60		

a. 20 cells (100.0%) have expected count less than 5. The minimum expected count is 1.80.

Statistical Anaylysis Bond Faliure



Shear Bond Strengths

When the enamel is ground to a flat surface, a more homogeneous structure of enamel prisms is produced, compared to the less well-defined aprismatic structure associated with surface enamel. The degree of calcification and fluoride content of the surface enamel might limit the depth of acid etching unlike the subsurface enamel that is less resistant to acid etching.Thus in this study the enamel was ground using an extra fine diamond burs (20-30µm grit) to obtain a flat surface.

Etching or conditioning enamel removes the surface contaminants and creates an irregular surface topography of micropores and micrprojections .The resin then penetrates and polymerizes in the enamel micropores and forms a mechanical bond with the tooth. It increases the surface wettability and the approximation between the sealant and substrate.

Apart from conditioning, it is proposed that the use of a bonding agent as an intermediate layer prior to the application of a sealant can provide better flow of the sealant to increase the bond strength. The bonding agents serve as low-viscosity flowable wetting agents for the interface between etched enamel and sealant, so that the viscous sealant spreads better and properly wets the surface of the fissures. The layer of bonding agent applied provides better flow of the thick highly filled sealant .This could be one of the reasons that could be responsible for the similar values of bond strength obtained with the two sealants. Also the surface evaluated was a relatively flat enamel surface where the effect of the viscosity of the sealant was of no significance unlike incase of pit and fissures where better penetration would be seen with the use of unfilled sealants. The sealant also is found to be more resistant to thermal and mechanical stresses in combination with the adhesive than when applied alone.

Bond strength tests are the most common way of evaluating the effectiveness of an adhesive system.Since the shear strength testing method is not applicable to the morphology of occlusal surfaces, the bonding performance of the adhesives underneath the sealants can be evaluated on flat ground enamel surfaces.A shear bond test using chisel on iris design is preferred as this technique directs the force more evenly on the bonded area and parallel to the bonded surface. It causes less of pretesting failures and allows ease of preparation and handling of the samples.

Contemporary adhesives can be divided into two systems in terms of clinical applications: etch and rinse adhesives and self-etch adhesives. In the self-etch adhesives, the acidic part of the primer dissolves the smear layer and incorporates it into the mixture as it demineralizes the tooth substrate and encapsulates the collagen fibers and hydroxyapatite crystals. An antibacterial adhesive used underneath the sealant will also exhibit antibacterial action on the cariogenic microflora of the pits and fissures and on the caries formation that may occur after microleakage or a partial loss of the sealant.Self-etch adhesive system containing antibacterial monomer 12-Methacryloxydodecyl pyridinium bromide (MDPB) has been introduced, which are more effective in antibacterial activity than cavity disinfectant solutions.Clearfil Protect Bond is one such adhesive used in the current study and tested for its shear bond strength to enamel.

Self etching primers have an acidic monomer in the priming agent, which

partially dissolves the smear layer and etches the enamel. They have higher pH resulting in shallow enamel demineralization compared to phosphoric acid .The acidic components of the self-etching primers do not create an enamel etching pattern as deep as phosphoric acid .This could be due to less demineralization of enamel by the priming agent compared to the total-etch system .In the current study the enamel was ground using Extra fine diamond burs (20-30µm grit) to a flat surface which could have also enhanced the bond strength of the self-etch groups equivalent to the single bond total-etch adhesive system.

In this study statistically significant difference was seen between the ormocer based total etch adhesive Admira bond and the rest of the groups. Due to the one-component nature of the all-in-one adhesive, it produces very thin hybrid and bonding layer which could lead to lower bond strengths.

Increased filler loading increases the viscosity of the bonding system may reduce its flow thereby preventing the adhesive from adapting properly and penetrating the etched enamel surface. This may in turn compromise the bond strength and marginal integrity . This could be the reason for the low bond strengths obtained with Admira Bond.

In the current study Clearfil Protect Bond, the antibacterial self-etch adhesive also gave high shear strength values, which was not statistically significant from that of Single Bond and Clearfil SE Bond. The high bond strength values could also be attributed to the fact that it is less technique sensitive and could form a homogeneous hybrid layer resulting in equal and constant bond strength.

It is seen that higher bond strengths normally produce more cohesive failures and fewer adhesive failures .This was due to the more effective depth of resin penetration in case of Single Bond, Clearfil SE Bond that not only produced greater bond strength but also increased the cohesive strength of the regions near to the interface. Thus the cohesive failure in the fissure sealant or enamel surface showed that the adhesion forces between the enamel and the adhesives in Groups I, II, III were stronger than the cohesive forces of the fissure sealant or tooth surface themselves.A shallow resin tag formation in enamel lead to lower bond strengths and there by adhesive failures in case of Groups IV and V.

Conclusion

Within the limitations of this study, it was found that the use of bonding agents beneath the pit and fissure sealants increases the shear bond strength and would increase the clinical success rate. Total-etch adhesive was superior to the conventional self-etch, an ormocer based adhesive and an antibacterial self-etch adhesive.Amongst the type of failures examined, more of cohesive failures in enamel were seen with increasing bond strength values. The sealants in the experimental groups showed 8.3% to 16.3% cohesive failure in the resin, 25% to 41.7% mixed failures, 16.7% to 33.3% structural failures in enamel and 16.7% to 50% adhesive failures.

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