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Original Research

Effect of adhesive system on retention of different sealants: an in vitro study

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ABSTRACT

Background: Fissure sealants' (FSs) clinical success is closely tied to their proper application and ability to achieve good adhesion.
Aim: To determine whether bonding agents with co-curing / staged-curing were more effective at retaining various resin-based sealants in permanent teeth than those without co-curing / staged-curing.
Materials and methods: 36 healthy extracted human premolars were selected and removed from debris/blood stains which were then mounted in acrylic resin with the buccal surface facing upward. The samples were etched with 37% phosphoric acid for 15 seconds and divided evenly into 2 groups I & II(n=18). Helioseal-F plus (group I) and Clinpro (group II). Each group was subsequently split into three subgroups, A, B, and C (n=6). Subgroup A (No-bonding) did not receive a bonding agent. Before sealant application, subgroup B (Staged-curing) received a bonding agent that had been cured. while subgroup C (Co-curing) received a cured adhesive system after the application of sealant. The shear bond test was tested by using the universal testing machine. A post hoc Tukey test and ANOVA (analysis of variance) were used to analyze the data.
Results: The results showed that the shear bond strength of group I (Subgroup IB) and group II (Subgroup IIB) which interact with staged curing was much greater than that of the other groups.
Conclusion: In comparison to no-bonding and co-curing using a bonding agent as staged-curing before the insertion of an RBS in permanent teeth increased shear bond strength.

***Keywords:** Pit and fissure sealant, Shear bond strength, Co- curing, Staged- curing, Adhesive System*

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INTRODUCTION

Dental caries remains a major global public health problem, according to the Global Burden of Disease Study, it is one of the most prevalent preventable non-communicable diseases worldwide, with an estimated 2.5 billion people affected and a 14.6% increase in dental caries over 10 years.[1] According to bio-statistics in 2011–2012 from the National Health and Nutrition Examination Survey (NHANES), pit-and-fissure caries make up nearly 90% of all permanent posterior teeth along with 44% affected in primary teeth. Paediatric dentistry must prioritize maintaining sound tooth structure and preventing dental caries.[2]

Simonsen RJ (1978) stated that pit and fissure sealants were introduced as a material that is inserted into the pits and fissures of the occlusal surface of the teeth that are prone to caries. They create a coating that is micromechanically adhered to the tooth surface, preventing caries-causing bacteria from accessing their supply of nourishment.[3]

Prabhakar et al. (2011) stated that there is a clear correlation between the length of the resin tags and the amount of microleakage. Pit and fissure sealants have a stronger caries-prevention effect when their resin tags are longer because it results in less microleakage.[4] Pit and fissure sealants physically occlude pits and fissures from the surrounding oral environment by adhering to the acid-etched enamel surface to perform their preventative role.[5] When using composite restorative materials, more conservative preparation is possible due to the clinical efficacy of adhesives.[6] Numerous studies have demonstrated the benefits of using an adhesive system in conjunction with resin-based sealants to improve the effectiveness of sealant placement.[7] Most common retention type of failure was observed in the resin-based pit and fissure sealant due to the failure of the bond between the resin dentin interface.[8]The application of a bonding agent may change the material's rheological properties, enabling it to flow more easily into the fissures and acid-etched surface.[6] Before application of the restorative material, an adhesive agent is usually cured. Prior to placement of the restorative material, an adhesive may need to be secured (staged cure).[9] This can result in the production of the homogenous hybrid layer that serves as an elastic cavity wall and releases the stress which is created during polymerization shrinkage.[10] The adhesive and restorative material are both cured simultaneously in the co-cured procedure. The co-curing approach has a shorter application time, which is advantageous when treating younger children.[9]

3M™ Clinpro™ pit and fissure sealant is an unfilled, fluoride-releasing, light-cured sealant with a unique ability to change colour, after being placed to the tooth surface, it is pink; when exposed to light, it turns opaque off-white in colour. Helioseal-F plus is a filled, fluoride-releasing, resin-based pit and fissure sealant.[11]

So, this study investigated to determine whether bonding agents with co-curing / staged-curing were more effective at retaining various RBS in permanent teeth than those without co-curing / staged-curing.

MATERIALS & METHODS:

Inclusion criteria:

- Intact premolars with completely formed apices
- Indicated for extraction for orthodontic purposes

Exclusion criteria:

- Carious teeth
- Crazed teeth / Fractured teeth
- Congenital defects
- Previously restored teeth

Sample size estimation:

Sample size calculation was performed using G*Power Version 3.1.9.4. 36 premolars were selected using an alpha (α) level of 0.05 with a confidence interval (CI) 95%. The minimum estimated sample size is 18 samples per group.

Sample preparation

All teeth (Fig.1) were free of biofilm and blood stains afterward they were kept in distilled water. Before testing the samples were sectioned by using a low-speed microtome and diamond disc under cooling, 1 mm below the cementoenamel junction (Fig.2), and the samples were embedded into a 1×1 cm self-cure acrylic resin block with the buccal surface facing upward (Fig.3). The buccal enamel surface of all samples was lightly sanded with carbide paper (grades 600–800) to create a rough plane that induces the adhesiveness of final materials.

Fig 1: shows extracted premolar teeth

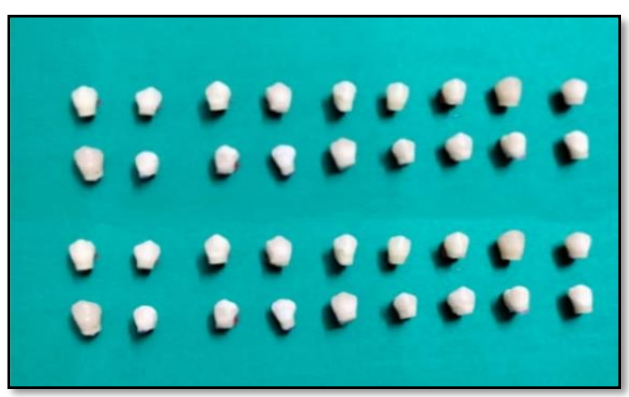


Fig 2 samples sectioned 1 mm below the cementoenamel junction

Fig 3: samples embedded into self-cure acrylic resin block

Fig 4: shows sample grouping

Samples grouping

All samples were arbitrarily divided into 2 groups and split into 3 subgroups.
Group I Helioseal-F plus (Ivoclar-Vivadent, USA)
Group II Clinpro (3M™ ESPE™ Minnesota, USA)
Subgroups IA & IIA: did not receive adhesive system (No bonding)
Subgroups IB & IIB: received cured adhesive system before applying sealant (Staged curing)
Subgroups IC & IIC: received cured adhesive system after the application of sealant (Co curing)
Each tooth sample was etched with 37% phosphoric acid for 15 seconds (Fig 5) and then washed and dried. Ia and IIa subgroups received no bonding agent (No bonding). Ib and IIb subgroups received two layers of a fifth-generation adhesive system (Ivoclar-Vivadent) following the application of airstream for each layer for 2-5 seconds (Staged-curing) then the bond was cured for 10 seconds. With the help of a 3mm diameter straw, a cylinder-shaped mould was fixed to the samples and PFS were inserted and cured (Fig 6). IC and IIC subgroups received two layers of adhesive bonding and the bond was not cured until the sealant material was applied (Co-curing). The samples were kept in distilled water at room temperature for 24 hours after curing to prevent dehydration.

Fig 5: shows the application of sealant according to group

Fig 6: shows after insertion of sealant

Laboratory Procedure

For shear bond strength test samples were sheared with a rectangular-shaped plunger and the crosshead speed was 0.5 mm/min by using a Universal Instron testing machine (Computerized, Software Based, ACME Engineers, India, Model: UNITEST 10, System Accuracy of the Machine: ± 1%) (Fig 7) and the outcomes were measured in megapascals (MPa).

Fig 7: Testing of shear bond test

Statistical analysis

Data was expressed as Mean ± Standard deviation ANOVA and Post- hoc Tukey's were done to assess the significance of the difference. P Value < 0.05 was considered to be statistically significant at 95% confidence interval. SPSS®24 (IBM Corp. NY, USA) and MS Excel® (Microsoft Corp. USA) were used for calculation purposes.

RESULTS

Each group's shear bond strength was described along with its mean, standard deviation, f- value and p-value. One-way ANOVA findings showed that all groups' bond strengths differed significantly from one another.

As inferred from Table 8 there is a significant difference between the mean values of shear bond strength in all three subgroups. Shear bond strength in subgroup I B was higher followed by subgroup I C and least value of shear bond strength has been recorded with subgroup I A.

As inferred from group II that is clinpro (3M™ ESPE™) shows the highest shear bond strength in the staged curing subgroup (II B). The minimum bond strength was seen in subgroup II A which is no bonding group.

Statistical analysis showed that shear strength of both group interactions with staged-curing was significantly higher than that of the groups with no-bonding and co-curing. Based on staged curing and co-curing subgroups the sealant groups did not differ significantly from one another.

1. Group	2. N	3. mean shear bond strength	4. SD	5. f-value	6. p-value
7. GROUP I A	8. 6	9. 1.8500	10. 0.36480	11. 12.348	12. 0.001 (s)
13. GROUP I B	14. 6	15. 3.9883	16. 1.00434		
17. GROUP I C	18. 6	19. 2.8133	20. 0.72803		

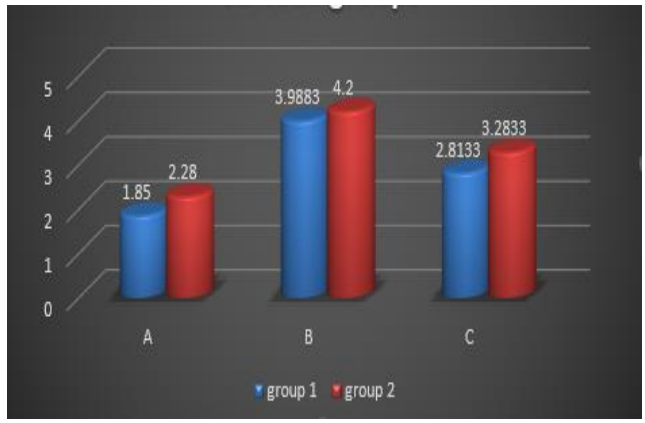
Statistical test: ANOVA; (p<0.05- significant, CI=95%), n.s- not significant, s-significant

Table 1: mean comparison of shear bond strength among group I

Group	N	mean shear bond strength	SD	f-value	p-value
GROUP II A	6	2.2800	.54321	10.52	0.001 (s)
GROUP II B	6	4.2000	1.04747		
GROUP II C	6	3.2833	.43066		

Statistical test: ANOVA; (p<0.05- significant, CI=95%), n.s- not significant, s-significant

TABLE 2: mean comparison of shear bond strength among group II



Graph 1: Comparison of two groups for the mean number

DISCUSSION

The best non-invasive method for avoiding occlusal caries is to seal the deep pit and fissure. Caries is more likely to occur on the occlusal surface.[12] This is particularly true for newly erupted molars, whose anatomical features make access difficult for cleaning treatments and inadequate enamel maturation increases the risk of caries. The efficacy of fluoride in the remineralizing phases is also diminished due to the occlusal surface's intricate morphology. Pit and fissure caries are extremely prevalent and persist despite fluoride protection, this is the justification in favour of using sealants as a preventive measure because these surfaces are less fluoride-protected than smooth surfaces. **Cueto and Buonocore (1967)** conducted the first clinical investigation on the retention of sealants. One year after the sealant was applied, they discovered an 86.3% decrease in caries. Furthermore, the kind of sealant employed affects the material's clinical durability.[13] In order to evaluate two different RBS materials, the SBS was measured on pre-treated enamel in permanent teeth that had undergone No-bonding, Staged-curing and Co-curing. The clinical effectiveness of restorative materials depends on the restorative materials' capacity to firmly attach to the dentinal surface and survive the various dislodging pressures which are present in the oral cavity. We inspected shear bond strength because it decides the clinical significance of the restorative material due to the shearing effect of the major dislodging stresses at the interface between the tooth and the restorative. Therefore, stronger shear bonds indicate good adherence with the material to the tooth surface. Instead of fissure modelling, we employed buccal surface modelling to standardise our research and to prevent variations in the architecture of pits and fissures that can skew the results. All teeth's buccal surfaces were taken into account as the bonded specimen must be precisely perpendicular to the shearing force. Except subgroups of Co-curing, we followed the manufacturer's directions for etching, bonding, sealant application and curing in the current study. We investigated the co-curing technique to see how well it improved sealant retention and how quickly it could be applied to permanent teeth, especially in reluctant youngsters.[14]

Pits and fissure sealants should be applied on the fissures of teeth where enamel is thought to be resistant to etching. When compared to the inner enamel layer, the sound enamel surface is devoid of prisms, hypermineralized that includes more inorganic material. Acid etching should be considered to produce short resinous tags that shows restricted porosity and enhanced resin penetration. However, compared to two bottle system, a self-etching primer system has a weaker effect on the aprismatic structure of enamel. In the majority of studies, enamel surfaces were flattened by silicon carbide paper before adhesive resins were applied for the bonding test. In the current investigation, flattened enamel

surfaces were created for the SBS due to technological challenges in determining the bond strength to undamaged enamel.[15]

In the present article, we employed a fifth-generation of an adhesive system to assess its impact on retention of two distinct sealant materials in order to standardise our study because utilising multiple bonding agents may cause bias in the final results and fifth-generation adhesive bonding is regarded as the gold standard. Based on the differences in their compositions, two sealant materials were chosen. Helioseal-F plus is a fluoride-releasing resin based sealants, whereas Clinpro is an unfilled RBS.[14]

Furthermore, the kind of sealant employed affects the material's clinical durability. The current in-vitro investigation was carried out to assess and examine the shear bond strength of two different kinds of pit and fissure sealants on premolars. In the current study, both types of sealants, filled and unfilled were utilised. Resin sealants have great wetting characteristics and low viscosity, just like unfilled ones.[16] For a liquid to flow over a solid, its surface tensions must be greater than one another. Less viscous sealants provide greater flow characteristics, which allows them to penetrate the crevices farther. The ability of a full sealant to fill a fissure would therefore be lower than that of an unfilled substance. The final polymers in filled sealants have different flow characteristics because the monomeric matrix has a different chemical makeup. In comparison to Bis-GMA monomer, urethane monomer may give the resin greater flexibility and adhesiveness. Our research revealed that Clinpro (unfilled sealant) improves enamel adherence because of its low viscosity property.[17]

Boksman et al. (1993) discovered that the application of the adhesive system before sealant application did not improve retention which is in contrast to our results but the findings of this investigation revealed that the Staged-curing subgroups had the highest shear strength results.[18]

Additionally, our results supported research by **Feigal et al. (2000)** that examined the impact of the adhesive system on sealant retention and they evaluated the effectiveness of the bonding agent to maintain the sealant retention to create a strong micromechanical interlocking because of the bonding agent's simple flow.[19]

According to **Pushpalatha et al. (2014)** Clinpro (unfilled sealant) demonstrated superior SBS when compared with Helioseal-F plus (filled sealant). This is consistent with the research’s findings, which revealed that Clinpro had the highest retention rate, with all pre-treatment techniques except Co-curing and this may be due to the low viscosity of the unfilled Clinpro sealant. Conversely, co-curing might alter Clinpro's flow, resulting in lesser retention than the other two pre-treatment procedures.[13]

Supporting the results of our study, **Tirali et al. (2013)** stated that pre-treatment adhesive techniques demonstrated higher bond strength than acid etching. This might be because the sealant and the etched enamel were tightly interlocked mechanically by the intermediate bonding layer.[20]

With limitations, the results could have been impacted by using a buccal surface design rather than a fissure design. Due to the existence of fissures with aprismatic enamel and other configuration parameters, buccal enamel with a fissured surface and enamel with a flat ground clearly differ from one another.

CONCLUSION

In comparison to no-bonding and co-curing using of bonding agent as staged-curing prior to the insertion of an resin based sealant in permanent teeth increased shear bond strength.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil

CONFLICTS OF INTEREST

There are no conflicts of interest

ABBREVATIONS

1. **RBS** : Resin-based sealants
2. **SBS**: Shear bond strength

REFERENCES

1. Van der Tas JT, Kragt L, Veerkamp JJ, Jaddoe VW, Moll HA, Ongkosuwito EM, et al. Ethnic disparities in dental caries among six-year-old children in The Netherlands. 2016a;50(5):489–97
2. Young DA, Nový BB, Zeller GG, Hale R, Hart TC, Truelove EL; American Dental Association Council on Scientific Affairs; American Dental Association Council on Scientific Affairs. The American Dental Association Caries Classification System for clinical practice: a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2015 Feb;146(2):79-86.
3. Simonsen RJ. Chapter 2: Pit and fissure sealants. In: Clinical Applications of the Acid Etch Technique, 1st Edn. Chicago, IL: Quintessence Publishing Co. Inc; 1978. pp.19-42.
4. Prabhakar AR, Murthy SA, Sugandhan S. Comparative evaluation of the length of resin tags, viscosity and microleakage of pit and fissure sealants—an in vitro scanning electron microscope Study. Contemp Clin Dent 2011;2(4):324–30.
5. Simonsen RJ. Pit and fissure sealant: review of the literature. Pediatr Dent. 2002 Sep-Oct;24(5):393-14.
6. Das UM, G S. Bonding agents in pit and fissure sealants: a review. Int J Clin Pediatr Dent. 2009 Sep;2(3):1-6.
7. Seraj B, Meighani G, Milani S, Fatemi M. Effect of Precuring and Postcuring of Total-Etch and Self-Etch Bonding Agents on the Microleakage of Fissure Sealants. Front Dent. 2019 Nov-Dec;16(6):421-28.
8. McCafferty J, O'Connell AC. A randomised clinical trial on the use of intermediate bonding on the retention of fissure sealants in children. Int J Paediatr Dent 2016; 26:110-5.
9. Chapman JL, Burgess JO, Holst S, Sadan A, Blatz MB. Precuring of self-etching bonding agents and its effect on bond strength of resin composite to dentin and enamel. Quintessence Int. 2007 Sep;38(8):637-41.
10. Lim W, Messer LB, Palamara JE. Bonding of resin composite precured or postcured to primary dentin. Pediatr Dent. 2014 Jul-Aug;36(4): 111-7.
11. Baheti AS, Bhayya DP, Gupta S, Kumar P, Shyagali TR. Assessment of clinical success of three sealants: Embrace-Wetbond, Clinpro, and Helioseal-F in permanent molars: an in vivo study. Pediatr Dent. 2020 Aug 26;3(1):7-13.
12. Knobloch LA, Meyer T, Kerby RE, Johnston W. Microleakage and Bond Strength of Sealant to Primary Enamel Comparing Air Abrasion and Acid Etch Techniques. Pediatr Dent 2005; 27:463-9.
13. Pushpalatha H, Ravichandra K, Koya Srikanth GD, Done V, Krishna KB, Patil V. Comparative evaluation of Shear bond strength of different Pit and fissure Sealants in Primary and Permanent teeth-An In-Vitro Study. J Int Oral Health, 2014,6(2):84-9.

14. Attar MH, Abdallah MA, Alharthy HA, El Meligy OA. Effect of Bonding Agent on Retention of Different Sealants: An in Vitro Study. Journal of Clinical Pediatric Dentistry. 2021;45(3):177-85.
15. Botsali M, Kuçukyilmaz E, Tosun G, Altunsoy M, Şener Y. Effects of adhesive systems applied under fissure sealants to microleakage and shear bond strength. Acta Odontologica Turcica. 2015 May 1;32(2):63-7.
16. Irinoda Y, Matsumura Y, Kito H, Nakano T, Toyama T, Nakagaki H, et al. Effect of sealant viscosity on the penetration of resin into etched human enamel. Oper Dent 2000; 25:274-82.
17. Droz D, Schilee MJ, Panight MM. Penetration and Microleakage of Dental Sealants in Artificial Fissures. J Dent Child 2004; 71:41-4.
18. Boksman L, McConnell R, McCutcheon-Jones E. A 2-year clinical evaluation of two pit and fissure sealants placed with and without the use of a bonding agent. Quintessence Int, 1993, 24(2): 131-33.
19. Feigal R, Musherure P, Gillespie B, Levy-Polack M, Quelhas I, Hebling J. Improved sealant retention with bonding agents: a clinical study of two-bottle and single-bottle systems. J Dent Res, 2000, 79(11): 1850-56.
20. Tirali RE, Celik C, Arhun N, Berk G, Cehreli SB. Effect of laser and air abrasion pretreatment on the microleakage of a fissure sealant applied with conventional and self-etch adhesives. J Clin Pediatr Dent, 2013, 37(3): 281-88.

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