In vitro comparative study of different methods of prophylaxis and conditioning of enamel in the adhesiveness of a pit and fissure sealant

Mandri, María Natalia*, Aguirre Grabre de Prieto, Alicia**, Zamudio, María Eugenia***

Abstract

The aim of this in vitro comparative study was to evaluate and compare the effect of different methods of prophylaxis and conditioning of enamel, in the adhesiveness of a light-curing pit and fissure sealant. The coronal portions of 50 extracted premolars were sectioned into two halves (buccal and lingual) and embedded in acrylic blocks. The samples were divided into five groups according to the methods of prophylaxis: no prophylaxis, pumice powder, chlorhexidine gluconate, fluoridated paste and air prophy; and enamel conditioning techniques: etching with 37 % phosphoric acid and self-etching adhesive. The sealant adhesion strength was measured using an INSTRON machine for a tensile test. The results showed no significant differences in tensile strength according to the enamel conditioning techniques used. Regarding the methods of prophylaxis under study, a significant difference in groups treated with fluoridated paste and air prophy was observed.

Keywords: Pit and fissure sealant, bonding, prophylaxis, tooth enamel.

* Senior Teaching Assistant. Department of Preclinical Operative Dentistry Universidad Nacional del Nordeste. Argentina.
** Professor. Department of Preclinical Operative Dentistry Universidad Nacional del Nordeste. Argentina.
*** Professor. Department of Biomaterials. Universidad Nacional del Nordeste. Argentina.

Received on: 10 Mar 16 - Accepted on: 05 Jul 16

Conducted at: Department of Biomaterials. School of Dentistry, Universidad Nacional del Nordeste. Av. Libertad 5450. Postal Code: 3400. Corrientes, Argentina

Introduction and background

Pit and fissure sealants can be effectively used as part of a comprehensive approach to caries prevention either on an individual basis or as a public health measure for at-risk populations (1). These materials are used to prevent the formation of caries and stop their progression as they provide a physical barrier that inhibits the accumulation of microorganisms and food particles in pits and fissures (2).

The materials used for sealing pits and fissures vary, as do the techniques used for applying them (3).

Bisphenol A glycidyl methacrylate (Bis-GMA) is a universally used material, although glass ionomers are also used (4).

As for techniques, the effective application and long-term retention of resin-based sealants requires an adequate prophylaxis of the enamel, acid etching of the surfaces and maintaining them in a dry field uncontaminated by saliva until the material is placed and polymerized (5).

Various studies mention additional techniques and recommendations, which can include adhesive systems, with selfetching systems evolving rapidly, different methods for mechanically preparing the enamel, such as air abrasion and enameloplasty, and the use of a four-handed technique (6-9).

Enamel prophylaxis means the application, before acid etching, of methods that remove plaque and organic debris without destroying the outermost layer (10). Various methods have been studied for the purpose of improving the efficacy of the adhesion of the sealant to the enamel surface. However, there is no consensus on which is the best method for cleaning pits and fissures prior to etching and sealant application (11).

Traditionally, the most used method is a mixture of pumice powder and water, but it has been noted that the use of pumice stone can leave a residue which may interfere with the acid etching process (12, 13).

There is some controversy on whether the use of a paste with fluoride before placement can affect sealant retention, because it will likely be impossible to achieve good acid etching of the enamel whose strength has been enhanced, but no specific evidence of this has been found (10).

In 1977, polishing with abrasive particles using polishing devices which release a controlled jet of very small particles that are more or less abrasive (aluminum oxide, silica or sodium bicarbonate) suspended in a stream of water on the surface of the tooth, was introduced to dentistry. This system has proven to be effective at removing plaque and staining from tooth surface (14).

In view of the above, the general aim of this study was to evaluate and compare the effect of different methods of prophylaxis and conditioning of enamel, in the adhesiveness of a lightcuring pit and fissure sealant.

Methods

We selected 50 healthy, young premolar teeth which had been removed for orthodontic reasons in the Dentistry University Hospital, School of Dentistry of the Universidad Nacional del Nordeste, and stored in distilled water until the study. This study was conducted in accordance with the ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki of the World Medical Association (15), and was approved by the Ethics Committee of the School of Dentistry of the Universidad

Nacional del Nordeste (Argentina).

To apply forces that are as perpendicular as possible to the enamel surface to be studied, the vestibular and palatal/lingual surfaces of each tooth were used. Therefore, the root portion was removed using a diamond bur, whereas the coronal portion was conserved by cutting it in a mesiodistal direction. The sections were then introduced in self curing acrylic to form a block.

Samples were distributed randomly into five experimental groups according to the variable to be analyzed (Table I).

EXPERIMENTAL GROUPS/ PRIOR PROPHYLAXIS	CONDITIONING OF THE ENAMEL	PIT AND FISSURE SEALANT
Group 1 **No prophylaxis**	Etching technique using 37 % phosphoric acid (10 samples) Technique using Adper Easy One® self-etching adhesive from 3M ESPE (10 samples)	3M ESPE Clinpro® light-curing sealant
Group 2 **Prophylaxis with pumice stone**	Etching technique using 37 % phosphoric acid (10 samples) Technique using Adper Easy One® self-etching adhesive from 3M ESPE (10 samples)	3M ESPE Clinpro® light-curing sealant
Group 3 **Prophylaxis with 0.12 % chlorhexidine gluconate**	Etching technique using 37 % phosphoric acid (10 samples) Technique using Adper Easy One® self-etching adhesive from 3M ESPE (10 samples)	3M ESPE Clinpro® light-curing sealant
Group 4 **Prophylaxis with fluoridated paste**	Etching technique using 37 % phosphoric acid (10 samples) Technique using Adper Easy One® self-etching adhesive from 3M ESPE (10 samples)	3M ESPE Clinpro® light-curing sealant
Group 5 **Prophylaxis with an air prophy**	Etching technique using 37 % phosphoric acid (10 samples) Technique using Adper Easy One® self-etching adhesive from 3M ESPE (10 samples)	3M ESPE Clinpro® light-curing sealant

Table I. Distribution of experimental groups

Acrylic blocks were also made and then a cylindrical retention cavity measuring 5 mm in diameter and 5 mm in depth was formed and filled with Z100 Composite to form a cylinder with the same diameter as the cavity, which protruded 3 mm from the acrylic block.

Once the two blocks were prepared, they were set in the universal testing machine INSTRON® model 3366 (Fig. 1), in the following positions:

- Top grip: block containing a polished and etched tooth.
- Bottom grip: block containing a Composite cylinder.

Samples were then aligned (Fig. 2) and brought closer until they touched. The sealant was light-cured in three different points and

the tensile mechanism was activated at a displacement speed of 1 mm/minute and a data acquisition rate of 1 value/200 ms, until the sealant was detached from the enamel, to test the bond strength.

Fig. 1. Universal testing machine INSTRON® model 3366

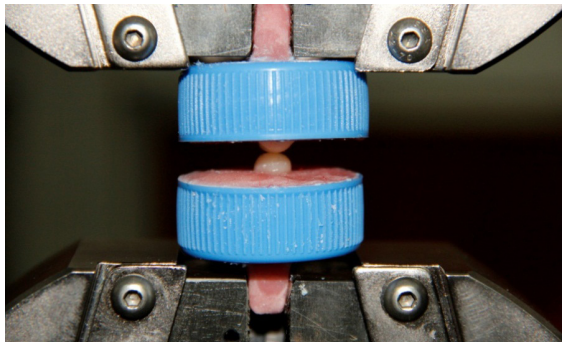

Fig. 2. Blocks aligned in the Instron® machine

The data obtained were analyzed using descriptive statistics, and the average values, along with their corresponding standard deviations and errors, and the analysis of variance (ANOVA) were calculated. Dunnett's multiple comparison of means test was applied for the enamel prophylaxis and conditioning methods studied. A significance level of $p \leq 0.05$ was established for all cases.

Results

Table II shows the descriptive statistics for each study group, measures of central tendency and measures of the spread of data. A significant increase in the maximum bond strength reached was observed in groups 4 (fluoridated paste) and 5 (air prophy) in comparison with groups 1 (control), 2 (pumice stone) and 3 (chlorhexidine gluconate 0.12%).

VARIABLE	N	MEAN	STANDARD DEVIATION	MIN. - MAX.	MEDIAN
G1- AET	10	3.2442	0.9360	2.0451- 4.8244	3.4689
G1- SEAT	10	3.6268	0.7302	2.7876 - 4.9234	3.5287
G2- AET	10	3.3701	0.9087	2.0705 - 4.9133	3.4302
G2- SEAT	10	3.8157	0.6140	2.9826 - 4.9811	3.8145
G3- AET	10	3.6811	0.6784	2.5887 - 4.6315	3.7066
G3- SEAT	10	3.8420	0.6381	2.9628 - 4.8712	3.7526
G4- AET	**10**	**4.0056**	**0.8972**	**2.5867 - 5.7012**	**4.0817**
G4- SEAT	**10**	**4.6336**	**0.9571**	**3.1377 - 6.0195**	**4.5536**
G5- AET	**10**	**4.7702**	**0.9267**	**3.1512 - 6.0972**	**4.6168**
G5- SEAT	**10**	**4.8996**	**0.7285**	**3.9826 - 6.4123**	**4.6169**

Table II. Summary Measures *AET: Acid-Etching Technique ** SEAT: self-etching Adhesive Technique

An analysis of variance (ANOVA) was performed on the results obtained for the different series tested. As for the enamel conditioning methods (acid-etch technique with 37 % phosphoric acid and technique using Adper Easy One® self-etching adhesive from 3M ESPE), we found that they do not significantly affect the maximum tension reached for each of the series tested, since all p values are higher than 0.05 (significance level used in the test). Regarding the prophylaxis methods tested, after applying Dunnett's multiple comparison of means test we found significant differences in Group 4 ($p = 0.041$) and Group 5 ($p = 0.014$) versus Groups 1 (control) and 2. No significant differences were found in Group 3 versus Group 1 (control), p value > 0.05.

Discussion

Prophylaxis was conducted using different methods as a preliminary step before conditioning the enamel for the application of the sealant (acid-etching technique and self-etching adhesive technique) in an attempt to enhance the bond strength between the enamel and the pit and fissure sealant. Enamel abrasion was used in most of the studies of similar characteristics that were reviewed. When the most aprismatic layer of the enamel is removed, the surface achieved can better interact with acid etching, which makes it possible to achieve higher bond strengths with resins, in this case, sealants. However, this procedure isn't traditionally performed before the application of a fissure sealant; rather it is associated with the technique known as enameloplasty (16, 17), which is slightly different from the sealing of fissures. Therefore, it was deemed convenient not to polish the outermost surface with discs, even at the expense of measuring tensile strength forces that are not completely perpendicular and obtaining lower results than in most studies (18-20).

As for enamel conditioning methods (acid-etching technique with 37 % phosphoric acid and technique using Adper Easy One® self-etching adhesive from 3M ESPE), we found that they do not significantly affect the maximum tension reached for each of the series tested. Our results are consistent with an in-vitro study conducted by Martinez Muñoz (21), who tested the adhesive strength of a liquid composite resin used as a pit and fissure sealant in different conventional application procedures and with additional bonding agents, and concluded that the latter do not significantly improve adhesion.

Regarding the methods of prophylaxis under study, a significant difference in groups treated with fluoridated paste and air prophy was observed. Our findings are consistent with a study conducted by Agrawal et al. (22), who had better results using an air prophy for prophylaxis prior to the application of a pit and fissure sealant since, according to the authors, it allowed for residual debris and biofilm to be completely removed from the base of the fissures.

Conclusions

We can conclude that in this "in-vitro" study, in which the effect of different methods of prophylaxis and conditioning of enamel, in the adhesiveness of a light-curing pit and fissure sealant was evaluated and compared we found that:

Enamel conditioning methods (acid-etching technique with using 37 % phosphoric acid and technique using Adper Easy One® self-etching adhesive from 3M ESPE) did not significantly affect the maximum tension reached for each of the groups tested.

Regarding the methods of prophylaxis under study, a higher tensile strength was observed in groups treated with fluoridated paste and air prophy.

References

1. Azarpazhooh A, Main PA. Pit and fissure sealants in the prevention of dental caries in children and adolescents: A systematic review. J Can Dent Assoc. 2008; 74 (2): 17177.
2. Zero DT, Fontana M, Martínez- Mier EA, Ferreira – Zandoná A, Ando M, González- Cabezas C, Bayne S. The biology, prevention, diagnosis and treatment of dental caries: Scientific advances in the United States. 2009; 140: 25 S- 34 S.
3. Ninawe N, Ullal Nayak AU, Khandelwal V. A 1-year clinical evaluation of fissure sealants on permanent first molars. Contemp Clin Dent. 2012; 3(1): 54–9.
4. Fernandes KS, Chalakkal P, Noronha de Ataide I, Pavaskar R, Fernandes PP, Soni H. A comparison between three different pit and fissure sealants with regard to marginal integrity. J Conserv Dent. 2012; 15(2): 146–50.
5. Yengopal V, Mickenautsch S, Bezerra AC, Leal SC. Caries-preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth: a meta analysis. J Oral Sci 2009; 51 (3): 373- 82.
6. Pelka MA, Altmier K, Petschelt A, Lohbauer V. The effect of air-polishing abrasives on wear of direct restoration materials and sealants. J Am Dent Assoc 2010; 141: 6370.
7. Moslemi M, Erfanparast L, Fekrazad R, Tayadon N, Dadjo H, Shadkar MM, Khalili Z. The effect of Er, Cr: YSGG laser and air abrasion on shear bond strength of fissure sealant to enamel. J Am Dent Assoc 2010; 141: 157- 61.
8. Khanna R, Pandey R K, Singh N, Agarwal A. A comparison of enameloplasty sealant technique with conventional sealant technique: A scanning electron microscope study. J Indian Soc Pedod Prev Dent [Internet] 2009. Cited: 2016 Aug; 27:158-63. Available from: http://www.jisppd.com/text.asp?2009/27/3/158/57096
9. Griffin SO, Jones K, Gray SK, Malvitz DM, Gooch BF. Exploring fourhanded delivery and retention of resinbased sealants. J Am Dent Assoc 2008; 139 (3):28189.
10. Covey DA, Barnes C, Watanabe H, Johnson WW. Effects of a paste free prophylaxis polishing cup and various prophylaxis polishing pastes on tooth enamel and restorative materials. Gen Dent. 2011;59(6):466-73.
11. Duangthip D, Lussi A. Effects of fissure cleaning methods, drying agents, and fissure morphology on microleakage and penetration ability of sealants in vitro. Pediatr Dent. 2003; 25(6):527-33.
12. Kolavic Gray S, Griffin SO, Malvitz DM, Gooch BF. A comparison of the effects of toothbrushing and handpiece prophylaxis on retention of sealants. J Am Dent Assoc. 2009;140(1):38-46.
13. Grasso CA, Caluori DM, Goldstein GR, Hittelman E. In vivo evaluation of three cleansing techniques for prepared abutment teeth. J Prosthet Dent. 2002; 88(4):43741.
14. Graumann SJ, Sensat ML, Stoltenberg JL. Air Polishing: A Review of Current Literature. J Dent Hyg. 2013; 87 (4) 173-80.
15. Declaración de Helsinki de la Asociación Médica Mundial. Gac Med Mex 2001; 137 (4): 38790.

16. Cho JS, Covey D, Abdelmegid F, Salama F. Effects of the preparation technique and type of material on the penetrability of sealants. Gen Dent. 2015; 63(4):e18-22.
17. Selecman JB, Owens BM, Johnson WW. Effect of preparation technique, fissure morphology, and material characteristics on the in vitro margin permeability and penetrability of pit and fissure sealants. Pediatr Dent. 2007; 29(4):308-14.
18. Moyaho-Bernal Á, Vaillard-Jiménez E, Soberanes-de la Fuente E, Franco-Romero G, Montiel-Jarquín AJ, Martínez-Fernández RG. A comparative study between two different technics for retention the pit and fissure sealants. Rev Med Inst Mex Seguro Soc. 2011; 49(1):13-6.
19. Ellis RW, Latta MA, Westerman GH. Effect of air abrasion and acid etching on sealant retention: an in vitro study. Pediatr Dent. 1999; 21(6):316-9.
20. Brown JR, Barkmeier WW. A comparison of six enamel treatment procedures for sealant bonding. Pediatr Dent. 1996; 18(1):29-31.
21. Simancas Y, Rosales J, Vallejo E, Camejo D. Microfiltración y capacidad de penetración de los selladores de fosas y fisuras: influencia de la técnica de aplicación. RAAO 2007; 46 (2): 28-33.
22. Montes de Oca Gómez S, Morales Zabala C, Yamamoto Nagano A. Valoración de la microfiltración en selladores de fosetas y fisuras empleando la técnica convencional con ácido fosfórico y un sellador con adhesivo autograbable en dientes contaminados con saliva artificial. Rev Odontol Mex 2010; 14 (4): 208-12.
23. Agrawal A, Shigli A. Comparison of six different methods of cleaning and preparing occlusal fissure surface before placement of pit and fissure sealant: an in vitro study. J Indian Soc Pedod Prev Dent. 2012; 30(1):51-5.

Natalia Mandri: nataliamandri@hotmail.com