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Adesão do Selante Clinpro™ XT à Superfície Oclusal de Molares Decíduos: Avaliação Longitudinal

Clinpro ™ XT Sealant Adhesion to the Occlusal Surface of Primary Molars: Longitudinal Evaluation

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Abstract

The study aims to evaluate the bond strength of sealants on deciduous molars. Clinpro ™ XT, Vitremer ™, Fluroshield and Optibond FL materials were applied to the occlusal surface of 40 deciduous lower molars (n = 5). The teeth were prepared for the micro tensile test, obtaining a specimen in a stick format with a cross-sectional area of 0.8 mm^2. After 24 hours and 6 months of restorative procedures, the specimens were traversed in universal test machine. The statistical analysis used the tooth as experimental unit, considering the adhesive and mixed fractures data, through Variance Analysis of repeated measures and Tukey tests (α = 0.05). There was a difference among the adhesion of the materials in 24 h, with higher union strength for Optibond FL (31.20 ± 1.36 MPa), significantly higher than that of Clinpro ™ XT (20.23 ± 1.16 MPa), Fluroshield (24.61 ± 2.76 MPa) and Vitremer™ (21.31 ± 2.32 MPa), which were similar. After 6 months of storage, the Clinpro ™ XT bond strength remained (22.18 ± 2.91 MPa), Optibond FL decreased (20.77 ± 1.53 MPa), but remained similar to that of Clinpro ™ XT in 6 months. The lowest adhesion values at 6 months were of Fluroshield (11.14 ± 1.98 Mpa) and Vitremer (5.29 ± 0.58 Mpa). It was concluded that the bond strength of the sealants to the occlusal surface of the deciduous molars was influenced by the material, with Clinpro ™ XT being the only material that maintained the bond strength values after 6 months.

Keywords: Pit and Fissure Sealants. Tensile Strength. Tooth, Deciduous.

Resumo

O presente estudo teve como objetivo avaliar a adesão de selantes em molares decíduos. Os materiais Clinpro™ XT, Vitremer™, Fluroshield e Optibond FL foram aplicados na superfície oclusal de 40 molares inferiores decíduos (n=5). Os dentes foram preparados para o ensaio de microtração, com obtenção de corpo-de-prova em formato de palito com área de seção transversal de 0,8 mm^2. Após 24 horas e 6 meses da realização dos procedimentos restauradores, os espécimes foram tracionados em máquina de ensaio universal. A análise estatística usou como unidade experimental o dente, considerando os dados de fraturas adesivas e mistas, pelos testes de Análise de Variância de medidas repetidas e Tukey (α=0,05). Houve diferença entre a adesão dos materiais em 24 h, com maior resistência de união para o Optibond FL (31,20 ±1,36 MPa), significativamente maior que a do Clinpro™ XT (20,23 ±1,16 MPa); Fluroshield (24,61 ±2,76 MPa) e Vitremer™ (21,31 ±2,32 MPa) foram semelhantes. Decorridos 6 meses de armazenamento, a resistência de união do Clinpro™ XT se manteve (22,18 ±2,91 MPa) e a do Optibond FL diminuiu (20,77 ±1,53 MPa) mas se manteve semelhante à do Clinpro™ XT em 6 meses. Os menores valores de adesão em 6 meses foram do Fluroshield (11,14 ±1,98 Mpa) e do Vitremer (5,29 ±0,58 Mpa). Concluiu-se que a resistência de união dos selantes à superfície oclusal dos molares decíduos foi influenciada pelo material, sendo o Clinpro™ XT o único material que manteve os valores de resistência de união após 6 meses.

Palavras-chave: *Selantes de Fossas e Fissuras. Resistência à Tração. Dente decíduo.*

1 Introduction

Caries is a lesion in the hard tissues, caused by an imbalance in the demineralization and remineralization of the tooth surface, and driven by the frequent access to fermentable carbohydrates, which causes a selection of local microbiota and increase the production of organic acids[1-3]. Its development influences the individual's quality of life, causes pain and is a relevant aspect in the consideration of the population's health condition[3]. Although there are ways to prevent dental caries, it is still present in the majority of Brazilian children at five years of age[4], and studies do not demonstrate a reduction in the incidence of dental caries in deciduous teeth[4-7]. In a situation where the risk of caries increases, the deciduous teeth are considered more vulnerable than the permanent ones[6].

There is a greater prevalence of lesions of dental caries in posterior deciduous teeth[8], possibly because the anatomical complexity of the molars favors the accumulation of food

debris and microorganisms in the pits and fissures of the occlusal surfaces, keeping the tooth surface as a site of high susceptibility[9] and predisposing these regions to the development of lesions[10.11]. Furthermore, the anatomy of the occlusal surface hinders the hygiene and the local action of fluoride, which causes the increase in the risk of developing dental caries in these regions[12]. For this reason, the use of materials that act as sealants of pits and fissures are considered good control agents of dental caries in the occlusal surface[13.14], since they act as a mechanical barrier against the accumulation of biofilm[15.16].

Sealants have been used as auxiliaries in the prevention of dental caries, there is evidence of their efficacy in preventing and delaying the evolution of the lesions of dental caries in children and adolescents[14,16,17] have. The presence of material on the surface of pits and fissures of teeth decreases the retention of food in the place and facilitates the hygiene, reducing the risk of developing dental caries in these areas[10.13]. Educational-preventive programs of dental care assistance for children since birth promote oral health education and perform preventive procedures in the Odontopediatrics context[18-20]. In addition to careful anamnesis and clinical examination, orientation activities of diet, oral hygiene instruction, control of dental biofilm and topical application of fluoride are commonly performed in programs for the prevention of dental caries[18,19,21]. However, the use of sealants of pits and fissures as preventive procedure is not commonly adopted[12,22,23], and few studies have demonstrated the importance of the use of sealants in deciduous dentition[22.24].

Systematic reviews and meta-analyzes are still incapable of presenting a conclusion about the effectiveness of different materials used as sealants of pits and fissures[25]. Recently a product in the form of hotopolymerized varnish was launched on the market, being described by the manufacturer itself as "site-specific ionomer sealant" - Clinpro™ XT Varnish, of 3M ESPE. The indications of the material include treatment of hypersensitivity of exposed roots and sealing of newly erupted teeth and other tooth surfaces (for example, on surfaces exposed to acid erosion and around orthodontic devices). Some advantages are described, such as the ease of application, slow release of fluorine, calcium and phosphate in the oral cavity, and high durability[26].

The studies found until the moment relating t Clinpro™ XT Varnish to the function of sealant of pits and fissures present good laboratory and clinical trials results in permanent teeth[27-32], justifying the cost of laboratory tests and clinical trials using the Clinpro™ XT Varnish as a sealant of pits and fissures of deciduous teeth. The objective of this study was to evaluate the bond resistance through micro tensile strength test of this new ionomer sealant used as sealants of pits and fissures in the occlusal surface of deciduous molars, compared with materials already described in the literature.

2 Material and Methods

The *in vitro* fertilization laboratory testing was performed after the approval of the Committee on Ethics in Research involving Humans Unopar, under the protocol 1.860.906/16. 40 healthy human deciduous molars were used, without caries or enamel defect, donated after dental extraction by therapeutic indication or natural scrub. The teeth were stored for seven days at 4 ºC in glass container with a lid containing neutral solution (pH=7.0) of chloramine-T (Vetec Química Fina; Rio de Janeiro, RJ, Brazil) at 0.5%, and the debris removed with periodontal curettes. The remaining roots, when present, were removed with diamond disc to separate the dental crowns and expose the pulp chamber.

2.2 Preparation of samples

The restorative procedures were performed by a single operator. The dental crowns were cleaned with pumice and water in brush of Robinson engaged in low speed turbine Koncept (Kavo Brazil Ind. Com. Ltda, Joinville, Santa Catarina, Brazil) during 20 seconds. The pulp chambers were cleaned and restored with adhesive system and composite resin, to prevent the tooth fracture during the preparation of the specimen for the micro tensile strength tests [33.34], following restoration protocol using dental adhesive tape, Adper Single Bond 2 (3M ESPE Dental Products, St. Paul, MN, USA) and photopolymerize composite resin Filtek Z250 (Color A3,5; 3M ESPE Dental Products, St. Paul, MN, USA) incrementally. The materials were photoactivated by Device CAL LED RADII (1200 mW/cm^2, SDI, São Paulo, SP, Brazil). The teeth storage was done in amber glass jar containing ultrapure water (Elga; PurelabOption-Q DV25; São Paulo, SP, Brazil) under refrigeration, for a maximum of 6 months[33].

2.3 Micro tensile Strength Testing

For the micro tensile strength test, 40 teeth were randomly distributed into 8 groups (n=5) in accordance with the used material (Clinpro™ XT, Optibond FL, Fluroshield, Vitremer™) and storage time (24 hours and 6 months). The dental crowns were then subjected to prophylaxis with suspension of pumice and water with brush of Robinson at low rotation speed, and sealants were applied on the occlusal surface of the teeth, in accordance with the indication by each manufacturer, as described in Table 1.

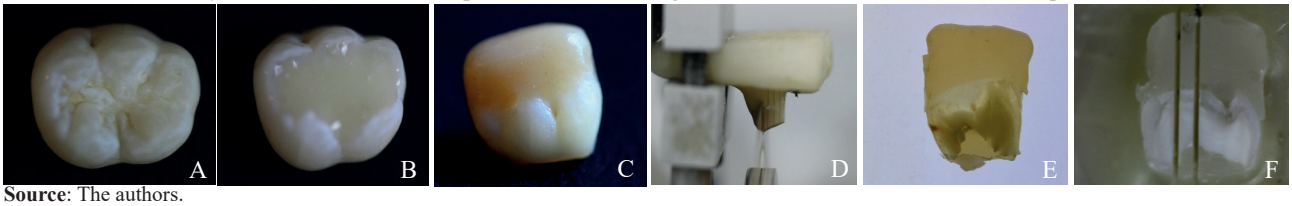
Table 1 - Dental materials used as sealants and mode of application as described by the manufacturer.

Material (Batch number)	**Composition**	**Mode of Application**
Clinpro™ XT (1600800529)	Paste A : fluoridealuminumsilicate glass (Silanized glass powder, Silica treated with silicon), hydroxyethyl 2-methacrylate (HEMA), water, bisphenol A diglicidil Dimethacrylate ether (BIS-GMA). *Paste B*: Copolymer of acrylic and itaconic acid, water, HEMA, camphoroquinone, calcium glycerophosphate	1 - Prophylaxis of surface 2 - Condition with phosphoric acid 37% the occlusal surface for 15 seconds 3 - Wash with water for 15 seconds 4 -Dry with air for 5 seconds 5 - Apply uniformly the sealant and photoactivate for 20 seconds
Optibond FL (Primer 3124126; Sealant 3101101)	*Primer*: HEMA Dimethacrylate Glycerophosphate (GPDM), mono 2-metacriloxietil phthalate (PAMM), ethyl alcohol, water, camphoroquinone Sealant: BIS-GMA, HEMA, GPDM, camphoroquinone, glycerol, Dimethacrylate	1 - Prophylaxis of surface 2 - Condition with phosphoric acid 37% the occlusal surface for 15 seconds 3 - Wash with water for 15 seconds 4 -Dry with air for 5 seconds 5 - Apply the primer under agitation (15 seconds) and dry with air (5 seconds) 6 - Apply uniformly the sealant in a single layer and photoactivate for 20 seconds
Fluoroshield (137100H)	Nupol monomer NCO, BisGMA, triethylene glycol dimethacrylate(TEGDMA), Penta, N-methyl Dietolamina, butylated hydroxytoluene (BHT), Dimethylaminoethyl 2n, camphoroquinone, Cervit T 1000, Barium Silanized, Sodium Fluoride, Cabosil TS 720 and 3328 Titanox	1 - Prophylaxis of surface 2 - Wash and dry 3 - Condition with phosphoric acid 37% for 30 seconds 4 - Wash with water spray for 15 seconds 5 - Dry 6 - Disperse the sealant on the surface with the aid of a brush 7 - Light cure for 20 seconds
Vitremer	*Primer*: HEMA, water, acid, photo initiator, polialcenoic acid Powder: *Silanised glass* , potassium persulphate, pigments *Liquid*: acrylic acid and itaconic acid, water, HEMA, camphoroquinone, Hexafluorophosphate diphenyl-iodonium	1 - Prophylaxis of surface 2 - Apply the vitremer primer for 30 seconds 3 - Apply air jet for 15 seconds followed by 20 seconds of light curing 4 - Agglutinate a portion of powder with 1 drop of coolant Vitremer for 45 seconds 5 - Take the material to the surface to be applied with the aid of a spatula and exploratory probe 6 - Light cure for 40 seconds

Source: Research data.

After the application of sealants and photo activation, rectangular blocks of composite resin Filtek Z250 were built incrementally (3 x 2 mm) on the occlusal surface[15,33,34]. The specimens were stored in ultrapure water for 24 hours at 37 °C, and after this period cuts were made with diamond disc (Extec 12205 High Concentration; Enfield, CT, USA) in the mesio-distal direction, in cutting machine of high precision (Isomet buehler Ltd, 1000; Lake Bluff, IL, USA). The cut resulted in slices of 0.9 mm thickness (first cut). Before the second cut, each slice was evaluated individually to select the regions with enamel interface/sealant as flat as possible. Then, each slice was cut individually to obtain canes with cross section area of[35] 0.8 mm^2, measured in digital caliper (Absolute Digimatic; Mitutoyo, Tokyo, Japan) (Figure 1). Each tooth resulted in obtaining 6 sticks, which remained stored in ultrapure water at 37°C during the entire experiment.

Figure 1 - occlusal view of the occlusal surface conditioned with phosphoric acid (A); applied sealant on the tooth surface (B); resin block built on the increment of sealant applied on the occlusal surface (C); Block positioned at the cutting machine of high precision (D); slices obtained by first cut (E); second cut, performed considering the interface sealant/enamel as flat as possible (F).



Source: The authors.

After the storage periods, each specimen was fixed on the basis of cyanoacrylate glue (Permatex, Odeme Biotechnology; Pompano Beach, FL, USA) by its ends in a device for the traction assay (V Claw, Odeme Biotechnology; Pompano Beach, FL, USA), coupled to a universal testing machine (EMIC DL2000; São José dos Pinhais, PR, Brazil) so that the

enamel/resin interface would be disposed perpendicularly to the application of load[36]. The traction test was performed at a speed of 0.5 mm/min, with the load cell of 50 N[33]. The calculation of the bond strength was performed in Mega Pascal, by dividing the value of breaking load (in Newtons (N) in the area of cross-section[36] (in mm^2). The fragments of the picks were observed under an optical microscope (Bel MicroImage Analyzer, Photonics, Italy at 40x magnification, for the classification of fractures in cohesive (enamel or material), tape (adhesive interface) or mixed (presence of material used and/or enamel in the same fragment).

2.2 Statistical Analysis

The statistical analysis used as experimental unit the tooth, using the software Statistix 9.1. The bond average strength of each group was analyzed to verify the sample distribution by Komolgorov Smirnov test, and then applied ANOVA (2 factors), material *versus* storage time, followed by the Tukey test, with a significance level of 5%.

3 Results and Discussion

Table 2 presents the mean of data relating to the adhesion of sealants to occlusal surface, after 24 hours and 6 months. Differences were observed among the materials (p=0.0001) and the time of evaluation (p=0.0001).

Table 2 - Average (standard deviation) of the bond resistance in MPa of different sealers to occlusal surface after 24 hours and 6 months

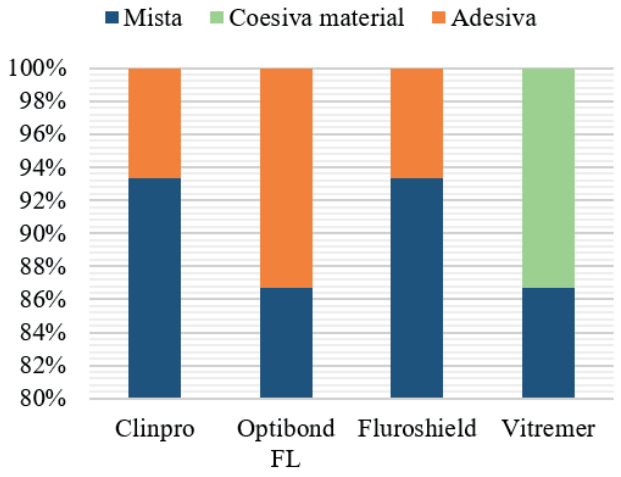
Material	Storage time	
	24 hours	6 months
Clinpro™ XT	20.23 (1.16) Ba	22.18 (2.91) Aa
Optibond FL	31.20 (1.36) Aa	20.77 (1.53) Ab
Fluroshield	24.61 (2.76) Ba	11.14 (1.98) Bb
Vitremer™	21.31 (2.32) Ba	5.29 (0.58) Cb

Different Upper case letters indicate statistically significant difference ($p<0.0001$), comparing each evaluation time among different materials. Different lower case letters indicate statistically significant difference ($p<0.05$), comparing each material in different times of evaluation.
Source: Research data.

In 24 hours, the highest value was observed when used as a sealant the dental sealant optibond FL (31.20 ± 1.36 MPa) and the results were similar in this period for materials Clinpro™ XT (20.23 ± 1.16 MPa), Fluroshield (24.61 ± 2.76 MPa) and Vitremer™ (21.31 ± 2.32 MPa). After 6 months of storage in water, the bond strength of optibond decreased significantly (20.77 ± 1.53 MPa), but remained similar to the values of Clinpro™ XT. Regarding the teeth sealed with Clinpro™ XT showed no reduction in adhesion after 6 months of storage (22.18 ± 2.91 Mpa). The teeth sealed with Fluroshield showed significant reduction in adhesion after 6 months of storage (11.14 ± 1.98 MPa), as well as teeth sealed with VITREMER™, which showed the greatest reduction in adherence to the tooth surface as time went by (5.29 ± 0.58 MPa), being significantly lower than the other tested materials in the same period.

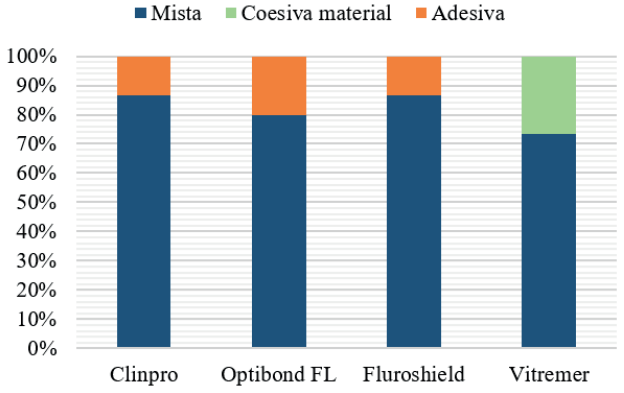
The analysis of the type of fracture showed predominance in fractures of the mixed type, for all groups, in relation to the cohesive and adhesive type fractures. There were no cohesive type fractures in tooth structure. Only the group sealed with vitremer presented cohesive fracture of the material in 24 hours (13.3%) and 6 months (26.7%), and were not observed adhesive-type fractures in this group (Figures 2 and 3).

Figure 2 - Analysis of the type of fractures of the different groups after 24 hours, expressed in percentage values (%).



Source: Research data.

Figure 3 - Analysis of the type of fractures of the different groups after 6 hours, expressed in percentage values (%).



Source: Research data.

The results showed greater adherence of the OptiBond FL at 24h, compared to Fluroshield, Clinpro™ XT and Vitremer™, which showed a similar adhesion. This result is consistent with other studies[11,15,33,34] and can be explained by the lower viscosity of the adhesive system, as compared to other materials. OptiBond FL fulfills adequately the micro porosities of enamel produced by acid conditioning[15], forming extensions of the material (tags) [37] that favored the adhesion. On the other hand, the highest viscosity of other materials may have resulted in less wetting of surfaces of the conditioned enamel, limiting the formation of extensions to the interior of the enamel, which can justify the lowest values of adherence among them in 24 hours. Irinoda *et al.*[38] have demonstrated, by means of microscopy, that sealants with lower viscosity penetrate with greater effectiveness in the conditioned enamel,

compared with more viscous materials.

Odontopediatrics presents limitations in the use of resinous sealants such as preventive material of the surface of deciduous molars by the difficulty of maintaining oral environment dry during the clinical care, which decreases the success in the retention of sealants[15,16,37]. Considering this difficulty, materials with simplified technique application and/or less sensitive to moisture are more indicated for the protection of pits and fissures of deciduous teeth, as the adhesive systems and the glass ionomer cements[39]. In this research, the adhesion of the ionomer glass resin-modified cement (Vitremer™) in 24 hours resulted in similar values to the resinous sealant Fluroshield, although it has been inferior to the OptiBond FL, perhaps due to the greater viscosity of the CIV rules in relation to the sealant.

The results of this study showed a decrease in the value of the adhesion of the optibond FL, Fluroshield and Vitremer™ after 6 months, which suggests the need for a shorter period between the clinical returns to the monitoring of teeth sealed with these materials, especially in patients with a high risk of developing caries. Failures of the sealants are associated with the development of caries, evidencing the importance of adequate adhesion to tooth structure to prevent the (re)colonization of cracks by microorganisms[29]. Studies have shown reduction in the durability of the adhesion of the sealants over time when observed in laboratory or clinical context[32.3912,17,32,40,41]. While in the clinical the contamination of surface that will receive the sealant material by saliva or gingival fluid were pointed out as the main reason of failures[12], particularities of the material used as a sealant may explain the lower adherence of some of them over time, as in the present study, which showed lower adherence of optibond FL, Fluroshield and Vitremer™ after 6 months. Moura *et al.*[33], in a study of longevity of adhesion of materials used as sealants, also observed a reduction in the values of the deciduous teeth sealed with optibond FL And Fluoroshield, after 6 months, suggesting that the methodology used could weaken the adhesion between the material and the dental friable enamel. In laboratory study comparing the adhesion of resinous and ionomer materials used as sealants, Papacchini *et al.*[40] also observed higher adhesion when used resinous base materials in enamel treated with phosphoric acid, compared with glass ionomer cements after treatment with *primers* indicated by the manufacturers.

In relation to Vitremer™, in our study, the adhesion after 6 months dropped sharply in relation to the period of 24 hours. Imbibition of water from the storage medium by cement[42] has probably happened, which might have undermined the adhesion. Clinically, this hypothesis should be considered, since the cement surface remains in contact with the saliva. Glass ionomer resin-modified cements exhibit less bond resistance to tooth structure, compared with resinous materials [40,43], in spite of the favorable results obtained by Khoroushi *et al.*[43] comparing the Vitremer™ with other glass ionomer resin-modified cements, applied in enamel.

Kühnisch *et al.*[41], in a review on the retention of the materials used as sealants, also observed that a large part of the studies of clinical evaluation involving ionomer sealants reported lower adherence with the passing of time. Another explanation for lower adherence verified with CIV could be the treatment of the surface of the enamel with poliacenoic acid indicated by the manufacturers, which causes a smaller degree of demineralization compared with the phosphoric acid[43]. Despite presenting lower adherence to the tooth structure and less visual retention in clinical studies, the CIV demonstrates fluoride release on the surface and particles of material are found in the cracks even after the material will not be visible on the surface[13,16,44], justifying its use as a sealant of pits and fissures.

The present study showed that the ionomer sealant Clinpro ™ XT is the only material that has kept the adhesion over 6 months. In a clinical test conducted by Gonçalves *et al.*[30] with sealing of permanent molars, comparing the Clinpro™ XT and the resinous Fluroshield sealant, it was observed greater visual retention on teeth sealed with Fluroshield. However, the clinical characteristics of surface roughness, staining and marginal integrity were similar for both materials, as well as the protection capacity of the development of caries. It has been suggested as an explanation of the clinical success of Clinpro™ XT the presence of resin components that would increase their retention rate and the physical and mechanical properties of the material[30]. Cabral *et al.*[32], in clinical study using the Clinpro™ XT and the CIV Fuji IX as sealants in permanent molars, observed lower visual retention after 24 months in teeth sealed with Clinpro™ XT, despite the similar efficacy between the materials regarding the prevention of dental caries. The favorable results in clinical tests using Clinpro™ XT as a sealant may be related with the maintenance of adherence observed in our study and high fluoride release, observed in laboratory study comparing the rate of fluoride release of Clinpro™ XT with other varnishes applied in deciduous teeth[45].

In a laboratory study evaluating the interface of Clinpro™ XT with the enamel of permanent molars and the chemical composition of enamel adjacent to the material, Pires de Souza *et al.*[29] observed a homogeneous interface between the material used as a sealant and the enamel. In images of scan microscopy and laser confocal microscopy, Pires de Souza *et al.*[29] describe the formation of contract extensions (*tags)* of the material, and the penetration of Clinpro™ XT in deep fissures, demonstrating the effectiveness of the retentive material. It was also observed a high amount of calcium ions and phosphorus in dental tissue underlying the applied material, possibly due to the presence of glass of fuorideaminosilicate and calcium glycerophosphate in its composition, which could explain the great potential of protection to the enamel demineralization observed in enamel protected with Clinpro™ XT[29] and constant adherence observed in this study. In addition, Clinpro™ XT offers great and constant

release of fluorine in the oral cavity[26,45,46], which could provide formation training to fluoroapatite and calcium fluoride by ion association with the enamel, and could prolong the retention of material on the tooth surface[47]. The association between the mechanical retention observed in resinous sealants and chemical adhesion proposed by glass ionomer could also explain the maintenance of adherence observed in our study, on the teeth sealed with Clinpro™ XT. Despite the clinical success described, few studies demonstrate the application of Clinpro™ XT as sealants of pits and fissures. Studies that may explain the resistance to chewing and wear by brushing, using the material as a sealant, and the influence of contamination by saliva on the accession of the Clinpro™ XT are required.

In the present study, a greater predominance of fractures of the mixed type in all the materials used was observed , with the presence of the tested material and enamel in the same fragment. These findings corroborate previous studies[15,48,49] that testing the adhesion of materials such as dental sealants also observed a greater number of specimens with mixed fracture, demonstrating a satisfactory bond between the material and the tooth structure.

Some limitations are observed in the present study: a laboratory study obtains control of important clinical variables, such as the moisture control, better visualization of the entire region caries (different from clinical studies); the use of materials by following the instructions of the manufacturers caused a difference in the conditioning acid time, and the use of different materials for the conditioning of different enamel, which may have negatively influenced the bond strength of VITREMER™. Before the challenges imposed in the clinical care of children patients, the results of this study suggest that the most suitable material for the sealing of the occlusal surface of the deciduous molars is the ionomer Clinpro sealant™ XT. However, clinical studies and with greater time of evaluation should be carried out to ascertain the durability of the adhesion of Clinpro™ XT when used as a sealant.

4 Conclusion

Given the above, it can be concluded that the bond resistance to the enamel of deciduous tooth was influenced by material used as a sealant of occlusal surface and by storage time, being the Clinpro™ XT the only material that kept the bond strength values after 6 months .

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