



Pesquisa Brasileira em Odontopediatria e
Clínica Integrada

ISSN: 1519-0501

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Brasil

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Pesquisa Brasileira em Odontopediatria e Clínica Integrada, vol. 15, núm. 1, 2015
Universidade Estadual da Paraíba
Paraíba, Brasil

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Original Article

A Comparative Study of Two High-Viscosity Ionomeric Cements for the Sealing of Newly Erupted Permanent Molars

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Academic Editors: Alessandro Leite Cavalcanti and Wilton Wilney Nascimento Padilha

Received: 16 November 2014 / Accepted: 28 September 2015 / Published: 12 November 2015

Abstract

Objective: To compare the retention and preventive aspects of two different types of high-viscosity glass ionomer cements for newly erupted permanent molars, considering the cost-benefit ratio in relation to public health. **Material and Methods:** fifty-four children (5-12 years) with erupted molars were selected. One hundred and fifty-four teeth were sealed, 75 with Ketac Molar (KM) and 79 with Vitro Molar (VM). Before and after sealant application, photos were taken and condensation silicone casts were produced in order to better classify tooth eruption stage and to assess the sealant retention rate. **Results:** Fifty-six percent of teeth sealed with KM showed fully retained material (FR) after the 5-month follow-up period; 18.4 % showed KM in two-thirds of the occlusal surface (partial retention 2- PP2); 23.7 % in one third of the occlusal surface (partial retention 1-PP1); and only 1.3 % of sealed teeth showed total loss (TL). Among teeth sealed with VM, 28.8 % showed total retention (TR) of the sealant after 5 months; 7.5 % of sealants were present in two-thirds of the occlusal surface (PP2); 10% were present in one third of the occlusal surface (PP1), and 53.7 % showed total loss of the sealant (TL). The development of only one active white spot caries lesion after total sealant loss was observed in the VM group. **Conclusion:** Occlusal surfaces of newly erupted permanent molars sealed with high-viscosity KM glass ionomer cement exhibited higher retention when compared to VM after a 5-the development of carious lesions in sealed teeth was similar in both materials, which confirms the good clinical performance of glass ionomer cement sealants in the evaluation period, being highly significant when considering the cost-benefit ratio in relation to public health (KM cost is 4 times higher than VM cost).

Keywords: Pit and Fissure Sealants; Dental Caries; Child.

Introduction

With the dissemination of prevention methods mainly based on the use of fluoride through public water supply and tooth brushing [1], a decline in prevalence and severity of dental caries has been observed both in developed and developing countries [2]. This decline occurred particularly in smooth-free surfaces. It is noteworthy that in smooth-free surfaces, oral hygiene practices and fluoride treatments are very effective in preventing caries due to easy access, which does not occur in the region of pits and fissures [3,4]. Thus, the use of additional preventive measures for these regions such as occlusal sealants becomes interesting [5].

Sealants are primarily designed for children at high risk for dental caries and low socioeconomic status due to lack of information and access to preventive treatments and highly cariogenic diet [6]. Molars at the eruption phase, where the retention of food residues and microorganisms is facilitated, also receive indication for the application of sealants [7]. Sealants can also have therapeutic indication in the case of active caries lesions located on the enamel or in early lesions located on the dentin [8].

Materials used for the sealing of pits and fissures are designed to form a mechanical barrier protecting this surface from contact with the oral environment and preventing the development of caries lesions [9]. Two types of materials can be used as sealants: resin and glass ionomer. The choice between resin and glass ionomer sealants should be made according to the amount of moisture at the site and tooth eruption stage. Moreover, past experience of dental caries or caries activity is important to be considered in the indication of occlusal sealants [8].

Resin sealants require good moisture control, which is difficult to be achieved during tooth eruption [7]. Glass ionomer materials are less sensitive to moisture and have the advantage of fluoride release, which benefits dental caries prevention because they increase the fluoride availability in the oral environment [10]. Ionomer sealants have lower retention rate as compared to resin sealants [8]. However, considering the preventive effect of the material, some authors report that even when the ionomeric sealant detaches from the occlusal surface, carious lesions do not develop [9], which could be explained by the permanence of the material at the bottom of the fissure and consequent fluoride release [11,12]. It should be emphasized that the glass ionomer cement not only releases significantly fluoride, but it can also recharge fluoride through professional topical application or by means of toothpastes and mouthwashes, which helps maintaining fluoride constant in the oral cavity. Thus, released fluoride provides protection to areas near the sealant, since in these areas, resistance to demineralization is greater. Moreover, released fluoride may promote remineralization of incipient carious lesions [13].

Even though scientific literature has already shown that the use of glass ionomer cement as sealant for pit and fissures is effective in preventing caries, few *in vivo* studies have considered the preventive effect of national materials in first or second permanent molars under eruption [14-16].

The aims of this study were to compare the effectiveness of glass ionomer sealants Ketac Molar - 3M and Vitro Molar - DFL in preventing occlusal caries in a 5- month follow-up period in a

sample of children of low socioeconomic status at high risk for dental caries, without fluoridation in the supply water, residents in the municipality of Três Forquilhas (RS); to compare, in the same period, the retention of two different high-viscosity glass ionomer cements in the sealing of the first and second newly erupted permanent molars, considering the cost-benefit ratio in the use of both materials.

Material and Methods

This study was previously approved by the Ethics Research Committee of the São Leopoldo Mandic School of Dentistry, protocol number 20120373. The study sample consisted of children aged 5-7 and 10-12 years of both genders attended at the Basic Health Unit of the city of Três Forquilhas (RS, Brazil). Inclusion criteria for this study were: age group, free and informed consent form signed by parents or guardians, molar teeth at least in stage 2 of tooth eruption [17], out of occlusion, children with past caries experience, presence of restorations, molars classified by ICDAS (International Caries Detection and Assessment System) [18] in 0, 1, 2 and presence of plaque on the buccal face of upper incisors.

Clinical Examination

Clinical examination was performed in the dental office at the Basic Health Unit of Três Forquilhas (RS). Intraoral examinations were performed by a single previously calibrated professional (kappa 0.90) and followed a systematic approach after prophylaxis with Robson toothbrush, pumice and water, washing and drying of tooth surfaces with a triple syringe. Caries diagnosis was visual using the ICDAS index and performed with the aid of mirror, cotton and sucking.

The ICDAS index takes into account both cavitated as non cavitated caries lesions. Surfaces were classified according to scores: 0 - no change in translucency of enamel after drying for 5 seconds; 1 - visible opacity after drying for 5 seconds; 2 - visible opacity even in the presence of moisture; 3 - caries located in an opaque or pigmented enamel; 4 - shade in underlying dentin; 5 - caries in opaque or pigmented enamel with exposure of underlying dentine 6 - caries in opaque or pigmented enamel with exposure of underlying dentine involving more than half of the surface [18]. This classification was performed by a single previously calibrated examiner.

Prior to sealant application, children had their first / second newly erupted molars classified as follows [17]: Stage 2 - the entire occlusal surface of the tooth erupting through the gums, common gingival operculum extending over the distal marginal ridge; or stage 3 - the entire occlusal surface was exposed and had no gingival operculum, but the distal gingival tissue was adjacent and at the height of the distal marginal ridge.

Children and adolescents also had a medical form completed, which contained data such as: name, age, caries index according to criterion of the International Caries Detection and Assessment

System (ICDAS) [18], presence or absence of clinically visible plaque on the buccal face of upper incisors and socioeconomic conditions.

Application of Sealants

Initially, teeth received prophylactic procedure using Robson toothbrush and pumice. Soon after, glass ionomer cements were handled according to manufacturer's instruction (rejecting the first drop and the flask was shaken before manipulation). Then, the occlusal surface was treated with polyacrylic acid for 15s.

Sealants used were Ketac Molar (3M ESPE) and Vitro Molar (DFL). Glass ionomer Vitro Molar (DFL) was chosen because it is routinely used for tooth sealing at the UBS due to its lower cost. Materials were tooled according to manufacturer's instructions, applied to molar teeth using the digital printing technique and protected by vaseline. Teeth 16, 17, 46, 47, 26, 27, 36 and 37 were randomly sealed with Ketac Molar or Vitro Molar (by draw). All children were selected, examined and treated by a previously trained and calibrated single professional.

Technique used for Sealing

For the sealing of occlusal surfaces, the following steps were taken: Brushing teeth with toothpaste (1100ppm F); Prophylaxis with Robson toothbrush, pumice and water; washing and drying; conditioning with polyacrylic acid, washing and drying. Initial photos (right side, left side, to check the eruption degree, upper occlusal, lower occlusal) using oral retractors and mirrors; Molding with condensation silicone (Clonage, DFL) using trays (Morelli) of appropriate size; Isolation with cotton rolls and sucking; material handling (with paper pad, plastic spatula - a portion of CIV for a drop of liquid, dividing the powder into two parts, 1 min for tooling until forming a homogeneous, smooth, glossy mass, forming a wire of 1 cm); Insertion on the occlusal surface with explorer; digital pressure after 2 min and application of vaseline; 2 min interval for final curing of the material; removal of excess coarse with probe or curette protecting with vaseline (with cotton); removal of the isolation and occlusion test; Molding with condensation silicone (Clonage, DFL) using trays (Morelli) of adequate size. Manipulation according to the manufacturer's instruction (handling of light and dense material at the same time, with 7min interval for the final curing); final photos (upper and lower occlusal); Guidance for the patient to remain at least 1 hour without eating and chewing on the side which tooth received the sealing for 24 hours; guidance for proper brushing.

Sealed teeth were re-examined after five months from application for evaluation of retention and effectiveness in preventing occlusal caries in the first and second newly erupted permanent molars.

Clinical evaluation of sealant retention was performed using criterion proposed by Pardi et al (19): TR - Total retention, PP1 - presence of sealant in two thirds of the occlusal surface, PP2 - presence of sealant in one third of the occlusal surface and PT - no sealant on the occlusal surface

[19]. Surfaces that have lost sealant were evaluated for the presence of caries according to ICDAS criteria.

After evaluation, sealed teeth were again photographed (upper and lower occlusal photograph) and received new molding with condensation silicone (Clonage, DFL). Photographs and molding were carried out in order to confirm data obtained for retention during clinical examination.

Data were tested for normality by the Lilliefors test and showed non-normal distribution. Therefore, to compare groups (Group sealing with Ketac Molar and Group sealing with Vitro Molar), the Mann Whitney test was used. The significance level of the statistical analysis was 5%.

Results

The total number of sealed teeth was 154 first and second molars, 75 were sealed with Ketac Molar and 79 molars were sealed with Vitro Molar.

Table 1 shows the clinical performance in relation to the retention of materials after 5 months of follow-up. The qualitative classification of sealant retention was transformed into quantitative by scores (TR=3, PP1=2, PP2=2, PT=0) and then VM and KM groups were compared using the Mann - Whitney test, which showed statistically significant difference ($p < 0.0001$).

Table 1. Clinical Performance (absolute number and percentage) regarding sealant retention after 5 months.

	Total	TR	PP1	PP2	PT
Ketac Molar (KM)	75	42 (56.0%)*	14(18.4%)*	18(23.7%)*	01 (1.3%)*
Vitro Molar (VM)	79	23(28.8%)*	06(7.5%)*	08(10.0%)*	42(53.7%)*

Asterisk indicates statistical difference by the Mann-Whitney test: $p < 0.0001$.

Of sealed teeth showing total sealant loss, only one had caries lesion (active white spot) (Table 2), the other did not develop caries lesions. In sealed teeth showing white spot at the beginning of treatment, after five months, these spots were found paralyzed. After 5 months, sample loss was 4 molars.

Table 2. Preventive effectiveness of sealants after 5 months of follow-up.

	Total Sealed Teeth	Total Losses	Dental Caries Development
Dental sealed with KM	75	1	0
Dental sealed with VM	79	42	1

Regarding the cost / benefit ratio of materials, national glass ionomer (VM), which costs on average R\$ 60,00, showed behavior similar to the imported material (KM), which can cost up to R\$ 260,00. Therefore, this result suggests that lower-cost material can be used in public health services with good results for caries prevention.

Discussion

Scientific evidence of recent decades have enabled a better understanding of the carious process [1,2,5,6,20]. The remineralization mechanism, the role of bacteria and fluorine, as well as additional information about the progression of the disease allowed that minimal intervention become one of the major strategies in the control of the caries disease.

The strategy for preventing caries in newly erupted permanent molars in the present study was the application of glass ionomer occlusal sealants on all children at the risk group for the disease in the city of Três Forquilhas (RS), as they should be target of these measures. For the classification of children as high risk for dental caries, in addition to unfavorable socioeconomic conditions and lack of fluoridation in supply water, past experience of the disease was observed, which is the most significant risk predictor for the development of caries lesions [15]. Although this study considered glass ionomer only for the sealing of newly erupted teeth in the city of Três Forquilhas (RS), high-viscosity glass ionomer cements, especially VM, are often used for both sealing of newly emerged molars and for sealing cavities with the aim of controlling dental caries. According to literature, the caries preventive effect of glass ionomer materials is unanimous [8,11,15,21,22].

This *in vivo* longitudinal clinical trial is one of the few [23,24] in literature using national CIV in the sealing of newly erupted molars in Brazilian children. The sealing of these teeth is interesting due to their increased susceptibility to dental caries (post-eruptive maturation phase and infra-occlusion), especially in children with caries activity and past caries experience, which is precisely the case of this study, as previously mentioned. The national material (VM) still requires testing for validation of its clinical performance. It has lower cost compared to KM, which is the gold standard [28]; however, it is best suited to the reality of Brazilian Basic Health Units, showing lower value compared to Ketac.

Regarding the characteristics of glass ionomer cements, the type of adhesion is an important feature for its indication. It has chemical bonding to the tooth structure based on the chelation of carboxyl groups of polyacids with calcium present in the apatite of enamel and dentin, and due to the increased mineral component of enamel, the bond strength is greater [25]. In addition, this type of bond is less sensitive to moisture. The application technique recommends that the surface to be restored must be conditioned with 10% polyacrylic acid for 10 seconds to increase the wetting capacity, the surface energy and improve the adaptation of the material. Our work strictly followed the prescribed technique. The results showed that sealing with KM had greater retention (56%) when compared to sealing with VM (53%) (Table 1); however, the preventive effectiveness of both materials was similar after 5 months (Table 2). Similarly [22], another study also found that after a period of 2 years, only 35% of sealants applied by the ART technique (Atraumatic restorative treatment) were present. In the same study [23], VM showed better clinical performance when used as sealant for dental caries, showing that in another situation where there is higher retention, its performance is enhanced. Another study [24] evaluated the quality of 111 ARTs using VM (86 restorations and 25 sealants) 12 months after procedure. Again, this fact emphasizes that the clinical

performance of VM can be improved when the application surface retentiveness is greater, as in the case of cavity. A systematic review [26] also proved this finding, showing in the 21 selected studies, satisfactory longevity of glass ionomer cements of intermediate or high viscosity using the ART technique in Class I cavities in primary and permanent teeth. The review also concluded that longevity is greater when high-viscosity CIV is used rather than low-viscosity CIV.

When comparing the clinical performance / retention of two glass ionomer sealants for the sealing of newly erupted permanent molars (16), conventional Vidrion (SS White) and high-viscosity ChemFlex CIV (Dentsply), no statistical difference between them was found. When comparing CIV modified by Vitremer resin (3M) with conventional Ketac-Bond CIV (3M), higher retention and preventive efficacy was found in the group of molars sealed with Vitremer due to the presence of resin components favoring its adhesion to the tooth structure [27]. In addition, they compared the clinical performance of Ketac Molar CIV (3M) and Fuji IX (GC) and concluded that both materials have similar results and may be used for occlusal sealing using the digital pressure technique [28]. Regarding this technique [29], the authors observed that glass ionomer sealants using the digital pressure technique obtained better results, probably because pressure favors greater penetration in regions of pits and fissures. These authors also found after one year, total retention of 60.3% and partial retention of 13.4% for sealants with Flee IX (GC) and no caries lesion was found. The fact that no carious lesion was observed is very similar to findings of the present study, as only 1 tooth developed white spot lesions.

A systematic review [5] verified a reduction of caries lesions in teeth sealed with CIV compared to molars that did not receive sealing. Other studies [6,8] have also confirmed that sealants are effective in children with high risk of developing caries lesions and can be used as an active agent in the control and monitoring of carious lesions, according to our results (Table 1). Prevention of dental caries in primary and permanent teeth was also confirmed by other studies [6,28,29]. A pilot study [15] of 5 years of observation after sealing emphasized the caries-preventive effect of glass ionomer sealants. All these findings corroborate results obtained in this study, where only one carious lesion occurred.

This study also suggests that the national material (VM) did not show favorable results regarding retention. However, it is possible that in a second evaluation after a longer period of time even after total loss, preventive effect is observed as shown in literature. Furthermore, the fact that sealants were evaluated only after 5 months is a limitation of this study, which will be remedied in future studies using longer periods of time. Another limitation of this study is that the experimental design was not split-mouth, where comparison is more homogeneous, since teeth with different materials are under the same conditions, i.e., in the same mouth.

Despite all the controversy regarding the retention of occlusal sealants, the main reason why sealants are used should not be forgotten: caries prevention [29]. Therefore, the present study is in agreement with previous studies [23,28,29], which showed that a large percentage of teeth sealed with CIV are free from caries in longitudinal assessments. The reasons for this effectiveness have

already been investigated and are assigned to the level of fluoride available in the enamel, in the biofilm and biofilm fluid, as well as the remaining residual material in pits and fissures, which often cannot be clinically detected [11].

Therefore, this work presents an alternative for the prevention of occlusal caries in high-risk populations with VM material after five months of follow-up, since in this period, VM and KM showed similar behavior in the prevention of caries development. A longer follow-up period should be used so that these results are confirmed. In addition, although sealants are the only instrument against a disease that is multifactorial and should be part of a wider prevention program, their use should be considered in Public Health Systems.

When it comes to public health, the cost / benefit ratio needs to be considered, especially in developing countries like Brazil, where dental caries affects more than half of the child population [30]. While national glass ionomer VM costs on average R\$ 60,00, KM can cost up to R\$ 260,00, or about 4 times as expensive. Therefore, with the use of VM, a number of teeth 4 times higher can be achieved with good results for caries prevention, which is quite interesting.

Conclusion

The sealing of newly erupted molars with high-viscosity glass ionomer Ketac Molar had higher retention compared to Vitro Molar on the occlusal surfaces of newly erupted permanent molars after 5 months of follow-up, suggesting a more satisfactory clinical performance. However, it is suggested that the preventive effectiveness regarding the development of caries lesions was similar in both materials, confirming the good clinical performance of glass ionomer sealant, being quite significant when considering the cost / benefit ratio in the public health system (cost KM 4 times greater than VM).

Acknowledgments

To companies DFL and Moreli for the donation of materials for this research.

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