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Evaluation of the effectiveness of conventional sealant and glass-ionomer cement as a preventive sealing material for first permanent molars

Nedana Georgieva, Krasimir Hristov, Nataliya Grancharova

Department of Pediatric Dentistry, Faculty of Dental Medicine, Medical University- Sofia

Abstract

Aim: *Comparative assessment of the wear and preventive effect of two materials - conventional sealant and glass-ionomer cement (GIC), in the coating of sound occlusal fissures of the first permanent molars.* ***Materials and method:*** *The study included 60 teeth in 30 children in the age group of 6 to 9 years. The teeth were diagnosed as "healthy" with code 0 (according to ICDAS II) by visual inspection. The diagnosis was also supported by the SoproLife camera. The teeth were divided into two groups: in 30 teeth the preventive sealing was made with light-curing sealant 3M Clinpro Syringe refill, in the other 30 teeth with GC Fuji IX GP. The follow-up period was 18 months and assessment and comparison of the abrasion of the used materials and their preventive effect was made.* ***Results:*** *According to the criteria used to assess their abrasion, the two materials show similarly very good results over the follow-up period. In both cases there is no loss of the material thickness, which would decrease their preventive effect. No occlusal carious lesion was reported during the observation period.* ***Conclusion:*** *Both materials are equally effective in preventing occlusal carious lesions in newly erupted first permanent molars. The glass ionomer cement used as a preventive sealant is probably the better material for less cooperative children, given its lower sensitivity to moisture when implementing the application protocol.*

Keywords: preventive sealing, permanent molars, glass-ionomer cementum, conventional sealant

Introduction

The occlusal surface is prone to caries lesion development, especially during dental eruption. The reasons for this are the lower degree of mineralization of the enamel in the area of fissures and pits and, accordingly, its lower resistance, the complex morphology of their occlusal surface, which favors the accumulation of dental biofilm. These surfaces are more difficult to clean due to their position in the dentition, the dexterity of children, and the problem of low awareness of parents about the importance of good oral hygiene at this age. (1, 2, 3)

Preventive fissure sealing of the molar teeth is the placement of material on them, which prevents the entry and retention of cariogenic microorganisms and their products in these often deep areas. Attempts to solve the problems associated with these areas of the tooth surface has begun at the beginning of the last century (in 1905 by Willoughby Miller). Over the years, various tools and materials have been used, both for prevention and sealing these risky tooth surfaces. (3, 4, 5) In 1974 McLean and Wilson introduced glass ionomer cement as a material for sealing the occlusal surface. (7)

Currently, different types of sealants are available: with and without filler; transparent and opaque, with color change after polymerization, with and without fluoride. (8, 9) The addition of fluoride to these materials aims to achieve a double effect – in addition to creation of a mechanical barrier limiting the accumulation and retention of microorganisms, low concentrations of fluoride in contact with the tooth surface increase fluorapatite and accelerate remineralization. (3, 10)

The introduction of glass ionomer cements (GIC) as a material for sealing the occlusal surface is based on the chemical bond with the enamel and dentin and the simultaneous release of fluorine ions in direct contact with the enamel surface. (11, 12) They are the preferred material for sealing in cases where the tooth eruption has not been completed (defined in the literature as "pre-sealing"), has a soft tissue operculum covering the occlusal surface and moisture control cannot be achieved. This is due to their hydrophilic properties. (12, 13)

The main problems in preventive sealing are related to accurate diagnosis of the condition of occlusal surface and the creation of optimal conditions for the implementation of the proper protocol given the age and cooperation of the patient and the need for moisture control. The characteristics of the material such as retention and wear resistance, risk of fracture, which create a high risk of developing a carious lesion in these cases are also important. (3, 13, 14) These main problems determined the purpose of the study.

Aim

The aim of this study was to make a comparative evaluation of the effectiveness of the preventive effect on the development of occlusal carious lesion after the use of conventional sealant and glass-ionomer cement as a sealing material and assessment of the durability and / or loss of both materials for a period of 18 months. An accurate assessment of the condition of the occlusal fissure morphology of the examined teeth was required to achieve the goal required.

Materials and methods:

The study involved 30 children, aged 6-9 years. An informed consent was signed by their parents. After caries risk assessment (according to the risk assessment tool used in the Department of Pediatric Dentistry, FDM, MU, Sofia) the children were categorized as high risk. Preventive sealing of deep fissures was performed on 60 teeth of these children.

Preliminary preparation of the teeth for assessment of condition of the occlusal surface:

- Cleaning the tooth with a brush with suitable profile, without paste;
- Directed light;
- Insulation with cotton rolls, aspiration and very good drying of the tooth.

The teeth were diagnosed as "healthy" by two methods - visual inspection and light fluorescence with an intraoral camera SoproLife. The ICDAS II diagnostic codes were used in the visual inspection.

Criteria for inclusion of teeth in the study:

- First permanent molars in occlusion (completely erupted) or in eruption, but with a completely exposed occlusal surface (without being partially covered with soft tissue), and which are asymptomatic.
- Code 00 (ICDAS II) and green color light tested with SoproLife.

The "split mouth" model was used in the study because each child had more than one suitable tooth, which allowed the application of both materials in one mouth. In this way the influence of the conditions in the oral environment on the studied materials is minimized and an objective comparison of the studied indicators is reported.

All children and their parents were educated about the technique of oral hygiene. Each child received written instructions about oral hygiene, the type of tooth brush and the use of fluoride toothpaste, as well as advice on eating habits, limiting the consumption of foods containing simple carbohydrates and the rules for their consumption.

Clinical protocol for application of light-curing sealant Clinpro Syringe refill 3M (according to the manufacturer's instructions):

1. The tooth surface is cleaned with a rotating cup-shaped rubber and a brush with a suitable shape to remove dental biofilm and food debris.
2. It is followed by washing and drying with water-air spray.
3. Isolation of the tooth (cotton rolls) in order to keep the surface clean and dry, which is relevant to the retention of the material. Aspiration is additionally provided.
4. The enamel is etched with 37% phosphoric acid for 30 seconds.
5. Rinsing for 20-30 seconds. Drying until the tooth surface is completely dry.
6. Etching assessment - the treated surface should look chalky white, matte and opaque. If this was not achieved, the etching was repeated. The same is applied when the child's behavior caused contamination of the etched surface with saliva.
7. The application of the sealant with an appropriate tip on the syring only within the borders of the pits and fissures. In order to achieve good penetration into the pits and fissures, the clinician waits for about 10 seconds before light curing. During this time, an inspection is made for the presence of void in the sealant. They were carefully eliminated with the help of the applicator, followed by light- curing for 40 seconds.
8. Evaluation of the procedure. It is performed by visual-tactile method, before removing the insolation. In the presence of void or areas with insufficient material, more sealant is added and light-cured. Occlusal contacts are checked using articulating paper. In the presence of preliminary ones, they are removed with the help of a fine round diamond bur (with a suitable size, applied only in the area) and a corner tip and water cooling. Then the surface is polished in order to remove the uncured layer.

Clinical protocol for application of glass-ionomer cement GC Fuji IX Extra:

1. Clean the tooth surface with a rotating cup-shaped rubber or with a brush to remove dental biofilm and food debris.
2. It is followed by washing and drying with water-air spray.

3. Isolation of the tooth (cotton rolls) in order to keep the surface clean and dry, which is relevant to the retention of the material. Aspiration is additionally provided.
4. The tooth surface was treated with GC Dentine Conditioner for 10 sec.
5. Rising for 10 sec.
6. Preparation of the material follows: The glass-ionomer cement is stirred on the automatic stirrer according to the manufacturer's instructions.
7. Application and polymerization. With an appropriate tip on the capsule, the material is placed on the fissure system of the occlusal surface in an appropriate amount, without excess. It is pressed lightly to enter the occlusal relief, wait 10 seconds to penetrate the depth of the fissures and pits. Light-curing for 20 seconds.
8. Evaluation of the procedure. It is performed by visual-tactile method, before removing the insolation. In the presence of areas with insufficient material, additional GIC should be added. Occlusal contacts are checked using articulating paper. In the presence of preliminary ones, the excess material should be removed, which is the same as for the sealant. It is obligatory to apply topcoat on the GIC.

Follow-up examinations to assess the coverage and health status of the examined teeth were performed on the 12th and 18th month.
The visual criteria used to assess the fissure sealant of the two materials are presented in Table 1.

Table 1. Fissure sealant assessment criteria:

Visual control	Preserved integrity of the sealing - 1 Defects in the sealant - 2 Complete loss of the sealant - 3 Caries development on the occlusal surface - 4

Assessment of the marginal integrity (borders) of the material was performed by visual-tactile inspection (with a mirror and a sharp probe). The aim is to find the retentive zones along the periphery of the material when passing the probe in different directions. In this way, the areas facilitating the accumulation of dental biofilm are identified. The movements of the probe were performed in 4 directions: from mesial to distal, from distal to mesial, from vestibular to lingual and from lingual to vestibular. The criteria for assessing marginal integrity are presented in Table 2.

Table 2. Criteria for marginal integrity of the sealing

Visual-tactile inspection	0 – no retention 1 – retention in one direction 2 – retention in two directions 3 – retention in three directions 4 – retention in all directions

The assessment of the condition of the material on each occlusal surface with fissure sealant according to the specified criteria was registered in an individul card of the 12th and 18th month, specially prepared for the purposes of the study.

Results:

At the 12th month after the application of the sealant and GIC no loss of the material in any of the observed teeth was found.
Table 3 presents the results of wear and marginal integrity of the conventional fissure sealant after 18 months.

Table 3. Wear and disrupted marginal integrity of conventional sealant after 18 months.

	N	%±SP	T-criteria
Without wear	27	90.00%±5.48	t= 10.33 p<0.05
With wear	3	10.00% ±5.48	
Total number	30	100%	

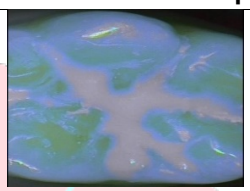
The results show that more than 2/3 of the sealant-covered occlusal surfaces show stability during the study with no abrasion or disruption of marginal integrity. Only 10% of the sealed teeth have a defect in the sealant coverage. The data identify the material as having high wear resistance, supported by statistical significance (p <0.05, Table 3).
Table 4 presents the results of wear and marginal integrity of the sealing made with GIC after 18 months.

Table 4. Wear and disrupted marginal integrity of preventive sealing with GIC after 18 months.

	N	%±SP	T-criteria
Without wear	28	93.33%±4.55	t= 13.46 p<0.05
With wear	2	6.67% ±5.48	
Total number	30	100%	

More than 2/3 of the occlusal surfaces sealed with GIC showed stability during the study and no abrasion and disruption of marginal integrity of the sealant was observed. Only 6.67% of the sealed teeth showed a defect in the material. Here again, the results determine the material with high wear resistance, supported by statistical significance (p <0.05, table 4).
Table 5 presents images of the examined teeth registered with SoproLife camera. It provides an opportunity not only for early diagnosis of carious lesions based on light fluorescence and for acquisition of images that can be used to track the examined tooth surfaces. Pictures of sealants with both materials at the beginning and after follow-up of 18 months are presented. Tooth 36 with preventive sealant and tooth 46 with preventive sealant of GIC were observed.
Disruption of the marginal integrity of both materials was not reported in the patient's reassessment. The registration of the images and the evaluation of the quality of the sealant was done with the intraoral camera SoproLife in the "blue light" mode, which monitors the presence of carious changes in the periphery of the material (Table 5).

Table 5. Photos of preventive sealing with sealant and GIC at the beginning and after 18 months

	Beginning	After 18- months	Reassessment of sealant after 18 months with intraoral camera SoproLife
3M Clinpro Sealant			
GC Fuji IX Extra			

Our results show that the two materials light-curing sealant 3M Clinpro and glass-ionomer cement GC Fuji IX Extra have similar wear resistance for a period of 18 months, which determines their preventive effect due to their ability to provide effective sealing of occlusal fissure system.

Discussion

In the present study, wear resistance and caries - protective effect of two of the most commonly used materials for preventive sealing of the occlusal surface were compared. Follow-up of the results revealed similar abrasion in conventional sealants and GIC (Tables 3 and 4).

Disruption of the marginal integrity of the materials must be considered as a result of a group of factors. On one hand are the qualities of the material, and on the other the possibility to achieve the best possible dryness of the surface. GIC is defined as a more viscous material, with lower flowability, in contrast to the sealant. GIC is less sensitive to moisture, which makes it more suitable for working with difficult and poorly cooperative children. This quality also determines the possibility of preventive sealing of teeth in eruption, where good tooth insulation cannot be achieved and there is a soft tissue over the tooth.

Both materials in the present study, according to the manufacturer, release fluoride, which in the specialized literature is considered a contributing factor in the prevention of the development of carious lesions. In both groups, the development of carious lesion was not found in the observed teeth for the indicated period of the study - 18 months.

According to a 7-year study comparing the retention and preventive properties of light-curing sealant and GIC used for preventive sealing, the sealant shows better retention to the tooth surface. (15) This is explained by the higher viscosity of the GIC. The same study demonstrated a more frequent occurrence of carious lesions after the use of GIC as a sealant. This claim is also supported by other authors (16,17,18) as they define the choice of GIC as a sealing agent as more financially unprofitable, given the need for more frequent corrections and reaplications, which are necessary as a result of faster abrasion. These data contradict a study conducted by other researchers who show that no carious lesion is observed after the use of GIC as a sealant in deep occlusal fissures and identify the material as more suitable in preventive terms. (19, 20)

A number of studies comparing the retention of GIC and sealant have shown no connection between field insolation with a rubber dam, considered optimal, and insolation with cotton rolls and good aspiration. (21, 22, 23) This is in support of the methodology used in the present study to apply the materials, given that early childhood in most cases hardly allows the use of a rubber dam. Our results showed that cotton roll insulation and good aspiration provide good retention of the materials used during follow-up for 18 months. The results on the loss of thickness of the two materials coincide with other studies conducted over the same period of 18 months. The same results were reported for a longer follow-up period - 24 months and 3 years. (21, 24, 25) Studies show that better retention of sealants is observed in patients aged 6-7 years, which is explained by the fact that the enamel is more porous. (26, 27, 28) The most appropriate time for preventive sealing of the occlusal surface is soon after the tooth eruption, which for the first permanent molars coincides with the above age, although there may be a failure in the application of the clinical protocol. (29) The final results we obtained coincide with a number of previously published systematic reviews and meta-analyzes on the topic. (30, 31)

Conclusion

The follow-up period of 18 months would have been considered short, but it allowed for eliminating the risk of losing motivation on part of the patients and their parents. The reported results show similarities in the resistance and caries preventive effect of conventional sealant and GIC.

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References

1. Jin-Dong Wang, Xi Chen, Jo Frencken, Min-Quan Du, Zhi Chen; Dental caries and first permanent molar pit and fissure morphology in 7- to 8-year-old children in Wuhan, China; International Journal of Oral Science (2012) 4, 157–160;
2. Elzbieta Luczaj-Cepowicz, Grazyna Marczuk-Kolada, Marta Obidzinska, Jarosław Sidun, Diagnostic validity of the use of ICDAS II and DIAGNOdent pen;
3. K. Bekes, Sotiria Gizani (ed.), Pit and Fissure Sealants, 23-35;
4. Zero DT, How the introduction of the acid-etch technique revolutionized dental practice. J Am Dent Assoc. 2013;144(9):990–4;
5. Feigal RJ, Donly KJ, The use of pit and fissure sealants. Pediatr Dent. 2006;28(2):143–50;
6. Buonocore M., Adhesive sealing of pits and fissures for caries prevention, with use of ultraviolet light. J Am Dent Assoc. 1970;80(2):324–30;
7. Asefi S, Eskandarion S, Hamidiaval S., Fissure sealant materials: wear resistance of flowable composite resins. JDent ResDent ClinDent Prosp. 2016;10(3):194–9;
8. Whyte RJ, Leake JL, Howley TP, Two-year follow-up of 1,000 dental sealants in first permanent molars in the Saskatchewan Health Dental Plan. J Public Health Dent. 1987;47(4):177–81;
9. Hiiri A, Ahovuo-Saloranta A, Nordblad A, Мдkelд M., Pit and fissure sealants versus fluoride varnishes for preventing dental decay in children and adolescents. Cochrane Database SystRev. 2010;17(3):CD003067;

10. Jensen ME, Wefel JS, Triolo PT, Hammesfahr PD., Effects of a fluoride-releasing sealant on artificial enamel caries. Am J Dent. 1990;3(2):75–8;
11. Aboush YE, Jenkins CB., An evaluation of the bonding of glass-ionomer restoratives to dentine and enamel. Br Dent J. 1986;161(5):179–84;
12. Mejare I, Mjцr IA., Glass ionomer and resin-based fissure sealants: a clinical study. Scand J Dent Res. 1990;98(4):345–50;
13. Alves LS, Zenkner JEA, Wagner MB, Damй-Teixeira N, Susin C, Maltz M., Eruption stage of permanent molars and occlusal caries activity/arrest. JDR Clin Res Suppl. 2014;93(7):1154–95;
14. Flamee S, Gizani S, Caroni C, Papagiannoulis L, Twetman S., Effect of a chlorhexidine/thymol and a fluoride varnish on caries development in erupting permanent molars: a comparative study. Eur Arch Paediatr Dent. 2015;16(6):449–54;
15. Sari Kervanto-Seppdld, Eeva Lavoinius, Ilpo Pietild, Janne Pitkdniemi, Jukka H. Meurman, Eero Kerosou, Comparing the caries-preventive effect of two fissure sealing modalities in public health care: a single application of glass-ionomer and a routine resin-based sealant programme. A randomized split-mouth clinical trial; International Journal of Paediatric Dentistry 2008; 18: 56–61;
16. Songpaisan Y, Bratthall D, Phantumvanit P, Somridhivej Y., Effects of glass ionomer cement, resin-based pit and fissure sealant and HF applications on occlusal caries in a developing country field trial. Community
Dent Oral Epidemiol 1995; 23: 25–29;
17. Forss H, Halme E., Retention of a glass ionomer cement and a resin-based fissure sealant and effect on carious outcome after 7 years. Community Dent Oral Epidemiol 1996; 26: 21–25;
18. Poulsen S, Beiruti N, Sadat N., A comparison of retention and the effect on caries of fissure sealing with a glassionomer and a resin-based sealant. Community Dent Oral Epidemiol 2001; 29: 298–301;
19. Mejare I, Mjör IA., Glass ionomer and resin-based fissure sealants: a clinical study. Scand J Dent Res 1990; 98:345–350;
20. Beiruti N, Frencken JE, van't Hof MA, Taifour D, van Palenstein Helderman WH., Caries-preventive effect of a one-time application of composite resin and glass ionomer sealants after 5 years. Caries Res 2004; 40: 52–59;
21. Asma AL-Jobair, Nouf Al-Hammad, Salwa Alsadhan, Fouad Salama; Retention and caries-preventive effect of glass ionomer and resin-based sealants: An 18-month-randomized clinical trial; Dental Materials Journal 2017; 36(5): 654–661;
22. Eidelman E, Fuks AB, Chosack A., The retention of fissure sealants: rubber dam or cotton rolls in a private practice. ASDC J Dent Child 1983; 50: 259-261;
23. Lygidakis NA, Oulis KI, Christodoulidis A. Evaluation of fissure sealants retention following four different isolation and surface preparation techniques: four years clinical trial. J Clin Pediatr Dent 1994; 19: 23-25;
24. Liu BY, Xiao Y, Chu CH, Lo EC., Glass ionomer ART sealant and fluoride releasing resin sealant in fissure caries prevention —results from a randomized clinical trial. BMC Oral Health 2014; 14: 54;
25. Oba AA, Dülgergil T, Sönmez IS, Doğan S., Comparison of caries prevention with glass ionomer and composite resin fissure sealants. J Formos Med Assoc 2009; 108: 844-848;
26. Al-Jobair A., Scanning electron microscope analysis of sealant penetration and adaptation in contaminated fissures. J Indian Soc Pedod Prev Dent 2013; 31: 169-174;
27. Waggoner WF, Siegal M. Pit and fissure sealant application: Updating the technique. J Am Dent Assoc 1996; 127: 351361;

28. Reddy VR, Chowdhary N, Mukunda KS, Kiran NK, Kavyarani BS, Pradeep MC., Retention of resin-based filled and unfilled pit and fissure sealants: A comparative clinical study. Contemp Clin Dent 2015; 6(Suppl 1): S18-23;
29. Feigal RJ, 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 DentRes 2000; 79: 1850-1856;
30. Mickenautsch S, Yengopal V. Caries-preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth:an update of systematic review evidence. BMC Res Notes2011; 4: 22;
31. Mickenautsch S, Yengopal V. Caries-preventive effect of highviscosity glass ionomer and resin-based fissure sealants on permanent teeth: A systematic review of clinical trials. PLoS One 2016; 11: e0146512.

Corresponding author:

Nedana Georgieva
Department of Pediatric Dentistry, Faculty of Dental Medicine,
Medical University- Sofia, 1 Georgy Sofiyski St
Tel.: 0887 085 555
e-mail: nedana.georgieva@gmail.com