A. T. Ulusoy, E.S. Tunc, Ş. Bayrak*

Department of Pediatric Dentistry, Faculty of Dentistry, University of Ondokuz Mayıs, Samsun, Turkey
**Department of Pediatric Dentistry, Faculty of Dentistry, University of Osmangazi, Eskişehir, TURKEY*

e-mail: sentunc@yahoo.com

Clinical performance of a glass ionomer sealant protected with two different resin-based agents over a 2-year follow-up period

ABSTRACT

Aim *To evaluate the effects of two different resin coating materials on the clinical performance of a conventional glass ionomer sealant.*
Subject and methods *Permanent first mandibular molars of 60 children aged 6-9 years were sealed with Fuji VII. In each child, G-Coat Plus coating agent was applied to molars on one side and Heliobond coating agent to molars on the opposite side of the mouth. Clinical evaluations were carried out at 1, 6, 12, 18 and 24 months after sealant and coating application.*
Results *At 1, 6, 12, 18 and 24 months after sealant and coating application, total sealant retention rates were 88%, 40%, 19%, 15% and 9% for molars coated with G-Coat Plus, and 93%, 47%, 17%, 15% and 7% for those coated with Heliobond. The differences between the two coating agents were not statistically significant (p>0.05). No incidence of caries was observed in either group during the two-year evaluation period. Statistics: Wilcoxon signed rank test was used to compare differences in retention rates and caries incidence by coating agent.*
Conclusion *Although retention rates of Fuji VII were relatively low and similar for both resin coating agents tested, dental caries were not observed in either group during the 24-month study period. In children with a high risk of caries and partially erupted molars, the use of a glass ionomer sealant with a resin-based coating agent should be encouraged.*

Keywords *Child; Decay; Glass ionomer fissure sealant; Preventive dentistry.*

Introduction

As the earliest and most common sites to be affected by dental caries, the anatomical pits and fissures of permanent teeth have long been recognised as areas particularly susceptible to the initiation of dental caries. Occlusal caries of the first permanent molars are most prevalent in children, especially during the eruption process, when the enamel is immature and neither the child nor the parents may be aware that a new tooth is erupting, or when the child may have difficulty cleaning the erupting tooth surface [Taifour et al., 2003]. The extreme vulnerability to decay of occlusal pits and fissures has prompted the search for measures to prevent the development of pit-and-fissure caries. The best caries prevention strategy currently available appears to be that of fluoride therapy in conjunction with the prudent use of pit-and-fissure sealants [Simonsen, 2002].

First developed in 1972 by Wilson and Kent [1972], glass ionomer cement (GIC) was designed specifically to be capable of chemically bonding with the tooth structure. Moreover, glass ionomer cement may exert a cariostatic effect through the release of fluoride, thereby reducing enamel solubility in acid [Maldonado et al., 1978], increasing fluoride concentrations in the adjacent dental tissue [Wesenger and Hals, 1980], enhancing enamel microhardness [Haznedaroglu et al., 2014], elevating plaque fluoride levels [Hallgren et al., 1993], and inhibiting growth of S. mutans [Loyala-Rodriguez et al., 1994]. Since its introduction, the use of glass ionomer cement for sealing occlusal pits and fissures has been considered to be an effective measure for caries prevention. The use of GIC has been suggested for erupting teeth where isolation is a problem [Gilpin, 1997], especially in the high caries risk individuals. One of the main clinical advantages of GIC is its ability to bond chemically to dentin and enamel without the use of the acid-etch technique, which makes GIC less vulnerable to moisture [Welbury et al., 2004].

In the initial stages of setting, conventional glass ionomer cement contains a high percentage of loosely bound water molecules and moisture-sensitive material. Dehydration or contact with water or saliva can cause the cement-forming calcium, aluminum and silicate ions to be leached from the material, leading to loss of translucency as well as decreased physical strength and increased susceptibility to disintegration, thereby reducing material longevity [Bowen and Marjenhoff, 1992; Chunk et al., 2001]. Surface coatings, including emollients such as cocoa butter and petroleum jelly, waterproof varnishes and methyl-methacrylate, amide and light–cured resins can help to overcome this major clinical problem [Bowen and Marjenhoff, 1992; Williams et al., 1998; Hattab and Amin, 2001; Chunk et al., 2001]. Numerous *in vitro* studies have been conducted to evaluate the effectiveness of surface-coating agents in protecting conventional glass ionomer cement [Earl et al., 1989; Hitt and Feigal, 1992; Hotta et al., 1994; Williams et al., 1998; Chunk et al., 2001; Karaoglanoglu et al., 2009; Lohbauer et al., 2011]. In most cases, resin-based, light-activated coating agents were found to perform better than other types of coating agents [Earl et al., 1989; Williams et al., 1998].

A new, nanofilled, resin coating agent, G-Coat Plus (GC Corp., Tokyo, Japan), was recently launched with the claim that it possesses all the properties of an ideal GIC sealant, including high hydrophilicity; however, no *in vivo* studies have yet to be conducted in support of this claim. Given the important role of sealant application in the prevention of newly erupted permanent first molars caries in children and adolescents, this study aimed to compare the use of two coatings, G-Coat Plus and the etch-and-rinse coating agent Heliobond, on the long-term clinical performance of glass ionomer sealant. The null hypothesis tested was that the application of G-Coat Plus as a coating agent on conventional GIC would result in higher sealant retention rates and lower rates of dentinal caries formation than the application of Heliobond.

Subjects and methods

Subjects

Study participants were selected from among those children seeking care at the Ondokuz Mayis University Department of Paediatric Dentistry in Samsun, Turkey, an area with a non-fluoridated water supply. Ethical approval for the study was granted by the Ethics Committee of Ondokuz Mayis University, and informed consent was obtained from the parents of participants.

The materials used in the study are listed in Table 1.

Children were selected based on the following criteria.

- Age (6-9 years).
- High risk of caries, according to the AAPD Caries Risk Assessment Tool (CAT)[2014].
- The presence of 1 healthy, newly erupted non-hypoplastic mandibular first permanent molar (FPM) in each quadrant with no restorations (based on visual inspection and probing).

Children who were judged insufficiently cooperative to allow sealant placement were excluded from the study.

A randomised bilateral study design was used in order to facilitate a direct comparison of material performance under similar environmental conditions. In total, 120 mandibular FPMs in 60 children aged 6 to 9 years (mean age: 7.9 years) were included in the study. Fuji VII (GC Corporation, Tokyo, Japan) glass ionomer sealant was applied to the selected teeth according to the manufacturer's instructions. Following sealant application, G Coat Plus (GC Corporation, Tokyo, Japan) was applied to 1 randomly selected FPM (Group GC) in each child, and Heliobond (Ivoclar Vivadent, Schaan, Liechtenstein) was applied to the contra-lateral FPM (Group HB).

Sealant and coating application

All procedures were performed by the same operator (ATU). Prior to sealant application, debris was removed from fissures using a rotating brush and water. Teeth were isolated using cotton rolls and a saliva ejector. Occlusal surfaces were gently cleaned with GC Cavity Conditioner (GC Corp., Tokyo, Japan) for 20 s, rinsed for 20 s, and blotted dry using a cotton pellet so that surfaces were not desiccated, but appeared moist and glistening. Pre-measured Fuji VII capsules were agitated in an amalgamator for 10 s, after which the sealant material was applied directly to the occlusal surface, generously spread on pits and fissures using a disposable nylon brush and shaped using a plastic filling instrument to a thickness of approximately 1 mm, with no step formation. After setting, finishing was performed using a smooth white stone mounted

Materials	Manufacturer	Composition	Type	Batch Number
GC Fuji VII capsule regular	GC Corporation, Tokyo, Japan	Fluoroaluminium silicate glass, polyacrylic acid, polybasic carboxylic acid	Conventional capsule glass ionomer selant	0805291
GC Cavity Conditioner	GC Corporation, Tokyo, Japan	Water, polyacrylic acid, aluminum chloride	Conditioner	0809021
Bac Phosphoric Acid	(Bisco, Inc. Schaumburg IL, USA)	35% phosphoric acid, benzalkonium chloride	Acid etching gel	0900006157
G-Coat PLUS	GC Corporation, Tokyo, Japan	Urethane methacrylate, methylmethacrylate, camphorquinone, silicon dioxide, phosphoric ester monomer	Nanofilled light curing self-etch bonding agent	0812041
Heliobond	Ivoclar Vivadent	Bis-GMA, Triethylene glycol dimethacrylate	Unfilled light curing etch&rinse bonding agent	M30777

TABLE 1 Materials used in the study.

in a micromotor handpiece.

Teeth in Group HB were conditioned with 32% phosphoric acid (UNI-ETCH, Bisco, Inc. Schaumburg IL, USA) for 15 s prior to surface coating, whereas no conditioning was performed prior to coating in Group GC. All surface coatings were applied according to the manufacturers' instructions and light-polymerized for 20 s using an LED curing unit (Elipar Free Light II, 3M/ ESPE, St. Paul, MN,USA; light intensity:1000mV/cm^2).

All children were instructed in proper oral healthcare behaviour and told not to eat or drink anything for 30 min following treatment.

Clinical evaluation

Clinical examinations were performed by a blinded examiner (SB) at 1, 6, 12, 18 and 24 months after sealant and coating application. Teeth were visually evaluated and classified as either sound (no dentin caries detected) or carious (dentin caries detected). Retention was visually evaluated using a mouth mirror and explorer, and teeth were classified according to Smales and Wong [1999], as follows.

I. Total retention (TR): Total retention of sealant on the occlusal surface.
II. Partial retention, type 1 (R1): Presence of sealant in 2/3 of the fissure extension, with small fractures and loss of material.
III. Partial retention, type 2 (R2): Presence of sealant in 1/3 of the fissure extension, large fractures and loss of material.
IV. Total loss (TL): No sealant present on the occlusal surface.

Defective or lost sealant was not replaced. No other exclusion criteria were applied.

Statistical analysis

Wilcoxon signed rank tests were used to compare retention rates of Fuji VII sealant coated with G Coat Plus and Heliobond, with a level of significance set at 5%.

Results

Table 2 shows retention rates at 1, 6, 12, 18 and 24 months following sealant and coating application. At 24 months, a total loss (TL) of sealant was observed on 23% of all sealed teeth (28/120).

Failure rates increased with time for both groups. Total retention rates at 1, 6, 12, 18 and 24 months were: 88%, 40%, 19%, 15% and 9% for Group GC and 93%, 47%, 17%, 15% and 7% for Group HB. Retention rates did not differ significantly between groups at any timepoint ($p>0.05$).

No incidence of caries was observed in either group over the 24-month evaluation period.

Discussion

The null hypothesis was rejected, given that there was no statistically significant difference between the retention rates of Fuji VII glass ionomer cement sealed with G-Coat Plus and Helliobond coating agents and no incidence of caries formation in any teeth at any time during the 24-month follow-up period.

The ability to obtain uniform environmental conditions is a key factor in assessing the clinical performance of restorative materials. Given that toothbrushing and dietary habits can have significant effects on the oral environment, the present study was designed as a split-mouth clinical trial with the same conventional glass ionomer sealant material and light-cured resin coating materials used in each subject in order to facilitate the clinical comparison between the two coating agents tested.

In this study isolation was achieved by using cotton rolls. It is obvious that the use of rubber dam is the safest way of securing optimal moisture control. However, this is usually not practical in young and newly erupted teeth as it demands the use of local analgesia for placement of the clamp [Welbury et al., 2004]. Moreover, there is sufficient evidence that careful isolation with cotton rolls gives similar retention results [Lygidakis et al., 1994]. Dental sealants have proven to be highly effective in preventing pit and fissure caries by inhibiting the impaction of food and bacteria, which produces acidic conditions conducive to caries formation [Simonsen, 2002]. In a population where the caries rate is moderate or high, the choice

	1 months				6 months				12 months				18 months				24 months			
	GC		HB		GC		HB		GC		HB		GC		HB		GC		HB	
RR	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
TR	53	88	56	93	24	40	28	47	10	19	9	17	7	15	7	15	4	9	3	7
R1	6	10	4	7	13	22	9	15	13	25	15	28	6	13	8	17	6	13	10	22
R2	0	0	0	0	13	22	14	23	6	11	13	25	11	24	15	33	8	17	13	28
TL	1	2	0	0	10	16	9	15	24	45	16	30	22	48	16	35	28	61	20	43
Total	60	100	60	100	60	100	60	100	53	100	53	100	46	100	46	100	46	100	46	100
	0.206				0.609				0.373				0.122				0.072			

TABLE 2 Retention rates of Fuji VII in Group GC and Group HB at the different recalls.

of sealant material may play an important role in caries prevention. Several studies [Ganesh and Tandon, 2006; Ashwin and Arathi, 2007; Ganesh and Shoba, 2007; Kamala and Hedge, 2008] have reported that the anti-cariogenic and fluoride-releasing properties of glass ionomer cement make its use as a fissure sealant an effective method of preventing the development of pit-and-fissure caries, especially in children with moderate or high caries rates. In this study, Fuji VII was selected as the sealant due to its ease of application, high level of fluoride release and pink hue, which makes it easier to detect sealant loss during follow-up visits. Nevertheless, in clinical practice, maintaining ideal conditions for glass ionomer sealant retention in the oral cavity may prove difficult with children. In order to overcome the problem of early water uptake and improve the clinical performance of glass ionomer materials, the use of a surface coating agent has been suggested [Earl et al., 1989; Bowen and Marjenhoff, 1992; Hotta et al., 1994; Williams et al., 1998; Hattab and Amin 2001; Karaoglanoglu et al., 2009]. However, some studies have suggested that the use of a coating agent may inhibit the release of fluoride from GICs, thereby limiting their cariostatic and antibacterial potential [Castro et al., 1994; Mazzaoui et al., 2000]. To date, there is no evidence that any reduction in fluoride release from glass ionomer that might occur after coating could have any clinically significant effect.

The present study found no significant differences in sealant retention rates between the groups; however, both groups showed a gradual loss of sealant over time (Table 2). This gradual loss of the Fuji VII used as a fissure-sealant material is in line with the findings of other clinical studies [Ganesh and Tandon, 2006; Ashwin and Arathi, 2007; Ganesh and Shoba, 2007; Kamala and Hedge, 2008].

In the present study, at 24 months of follow-up, a total loss of sealant was observed in 61% of teeth in Group GC and 43% of teeth in Group HB and a partial loss of sealant in 50% of the teeth in both groups. Despite the relatively low retention rates, no incidence of dentin caries was observed in either group during the 24 months of follow-up. This finding is in line with other clinical studies [Pardi et al., 2003; Periera et al., 2003; Kamala and Hedge, 2008]. It has been suggested that even in the case of partial loss, enough material remains in the deeper parts of the fissures to prevent caries [Wendt and Koch, 1988]. Even the small amounts of material remaining in the fissures appear to have a cariostatic effect due to the glass ionomer sealant's inherent properties of fluoride release and its ability to adhere to dental structures [Pardi et al., 2003; Ganesh and Shoba, 2007]. In the present study, the fact that no caries were observed in 24 months of follow-up makes it possible to suggest that the application of a coating agent does not impair the cariostatic properties of Fuji VII. Similarly, previous clinical studies have shown no evidence to indicate that the application of a coating agent has any detrimental effect on the cariostatic potential of glass ionomer materials. In fact, a number of clinical studies have shown the use of a light-cured resin as a sealant coating to be effective in decreasing water penetration, thereby protecting the sealant material [Earl et al., 1989; Ribeiro et al., 1999]. The nanofilled, self-adhesive resin bonding agent G-Coat Plus (GC Corp., Tokyo, Japan) was recently launched for the dental market with the claim that it possessed all the properties of an ideal protective coating agent; however, this study found no statistically significant difference in the retention rates of the Fuji VII GIC used as a fissure sealant when coated with the self-adhesive G-Coat Plus as compared to the etch-and-rinse adhesive Heliobond. The reason for this remains unclear. It is well-known that glass ionomer requires protection from moisture and dehydration, not only during the early setting stage, but significantly beyond this time period, as the material may require up to several months before it establishes its final physical and chemical properties [Serra et al., 1994]. While masticatory wear will result in a loss of sealant coating over time, no studies have been conducted to determine the length of time for which coatings remain intact on GICs, which also become more moisture-resistant as they take on their final characteristics.

One limitation of the present study is that it did not include uncoated control groups, making it impossible to compare the retention rates of coated and uncoated glass ionomer sealants. Therefore, further studies are needed to assess such potential differences in clinical performance.

Conclusion

Within the limitations of this clinical study it may be concluded that the use of glass ionomer cement as a fissure sealant should be encouraged in children with a high risk of caries and partially erupted molars, rather than following the traditional approach and waiting for full eruption before applying a sealant. Moreover, considering that similar retention rates were observed for both coating agents tested, the use of a self-etch adhesive coating agent may be preferable in paediatric patients due to the simplicity of application when compared to an etch-and-rinse coating agent.

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