COMPARISON OF GIOMER AND FLUORIDE RELEASING RESIN SEALANTS IN CARIES PREVENTION AMONG PRIMARY MOLARS

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Abstract. Dental sealant is used to prevent caries progression. We aimed to compare the effectiveness of giomer and fluoride releasing resin sealants for preventing caries in primary molars *in vivo*. We conducted a randomized control trial among children aged 2½ -5 years. In each subject, the primary molars on one side of the mouth were treated with giomer sealant and the contralateral primary molars were treated with fluoride releasing resin sealant. The teeth of each child were examined at 1, 3, 6, 9, and 12 months after the sealant was applied. Sealant retention rates and the presence of caries were determined at each visit. Sealant retention was classified into complete retention, partial loss, and complete loss. Caries were classified as being present or not present. Study subjects were chosen from 2 kindergartens. A total of 116 subjects were included in the study. The percentages of subjects with giomer sealant who had complete retention were 73.3%, 39.1%, 19.0%, 16.4%, 14.7% while those with fluoride sealant with complete retention were 96.5%, 87.1%, 76.7%, 75.0%, and 72.4% at 1, 3, 6, 9, and 12 months, respectively. The percentages of subject with giomer sealant who had partial loss of sealant were 23.3%, 46.6%, 42.2%, 42.2% and 41.4% while those with fluoride sealant with partial loss were 3.5%, 12.1%, 21.6%, 21.6%, and 22.4% at 1, 3, 6, 9, and 12 months, respectively. The percentages of students with complete loss of giomer sealant were 3.4%, 21.6%, 38.8%, 41.4%, and 44.0% while those with fluoride sealant were 0%, 0.8%, 1.7%, 3.4%, and 5.2% at 1, 3, 6, 9, and 12 months, respectively. The subjects with fluoride releasing sealant had significantly higher ($p<0.05$) retention rates than those with giomer sealant. The percentages of subjects with fluoride releasing sealant who had progression of caries were 0%, 13.4%, 25.9%, 27.6%, and 28.1% while those who used giomer sealant were 3.2%, 6.3%, 17.1%, 20.7%, and 23.2% at 1, 3, 6, 9, and 12 months, respectively. The percentages of those with fluoride sealant who had caries regression were 0%, 46.6%, 51.9%, 44.8%, and 40.6% and those with giomer sealant were 19.4%, 39.3%, 50.0%, 47.4%, and 47.5% at 1, 3, 6, 9, and 12 months, respectively. Finally the percentages of those with fluoride sealant who had no change in the caries were 100%, 40%, 22.2%, 27.6%, and 31.3% and those who used giomer sealant were 77.4%, 54.4%, 32.9%, 31.9%, and 29.3% at 1, 3, 6, 9, and 12 months, respectively. The results show the fluoride sealant was

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significantly (p<0.05) more effective at preventing caries than giomer sealant. Our results show fluoride releasing resin sealant is more effective at preventing caries and has better retention than the giomer sealant *in vivo* for primary molars.

Keywords: giomer, sealant, *in vivo* efficacy, primary tooth

INTRODUCTION

Dental caries are a major public health problem in young children. Fifty-one point seven percent of Thai children are estimated to have dental caries and the mean number of decayed, missing and filled primary teeth (dmft) among those children is estimated to be 2.7 (Ministry of Public Health, 2012).

The occlusal surface is susceptible to caries because of pits and fissures (Feigal, 2002; Wright *et al*, 2016). In primary teeth, dental caries can occur in up to 10-20% on this surface (Ministry of Public Health, 2012). Most children with dental caries go untreated (Ministry of Public Health, 2012). Sixty-two point seven percent of three-year-old Thai children need sealant (Ministry of Public Health, 2012). Therefore, sealing these pits and fissures may reduce caries (Beauchamp *et al*, 2008).

Applying sealant to primary and permanent teeth can reduce caries progression (Feigal, 2002; Beauchamp *et al*, 2008). One study concluded sealant should be applied to primary teeth of children who are at high risk for caries (Beauchamp *et al*, 2008). Dental sealants can reduce the risk of developing new caries by 76% and 79% at 3 and 7 years follow-up, respectively (Wright *et al*, 2016).

There are two main types of dental sealant: resin and glass ionomer sealant. Resin-based sealant has been used for primary molars for many years because of its high retention properties; a main disadvantage is its hydrophobic characteristics (Subramaniam *et al*, 2008). Due to the sensitivity of the technique to moisture, it is not commonly used in young children. Both glass ionomer sealant and resin can release fluoride but glass ionomer sealant has an advantage. It is easy to apply because there is no need to use the acid-etch technique to prepare the occlusal surface. A problem with the glass ionomer is that there is a 5 times greater chance of sealant loss compared to resin sealant at 3 years of follow-up (Wright *et al*, 2016).

Giomer sealant claims to have the advantages of both glass ionomer and resin sealant. Giomer sealant is resin-based and contains a surface pre-reacted glass ionomer (S-PRG) filler. This particle releases various ions, including fluoride, strontium, aluminum, sodium, boron and silicate (Quader *et al,* 2012). Some *in vitro* studies found giomer sealant to have higher fluoride recharge ability than other fluoride releasing sealants (Shimazu *et al*, 2011; Dionysopoulos *et al*, 2016; Salmeron-Valdes *et al*, 2016). The manufacturer claims that giomer sealant is easier to apply because it has a self-etch primer and no water rinsing is needed (Giannini *et al*, 2015). Due to this ease in application, giomer sealant might be a better choice for sealant in young children. There are no published studies of the efficacy of giomer sealant. Therefore, we aimed to compare the *in vivo* efficacy of resin-based fluoride releasing sealant with giomer sealant to prevent caries and caries progression and to compare the retention of both these sealants for primary molars of school

children from 2 kindergartens in Thailand.

MATERIALS AND METHODS

Subjects

The study subjects consisted of healthy children aged 2½ - 5 years attending 2 kindergartens in Thailand. Other inclusion criteria were having at least one pair of primary maxillary or mandibular second molars with deep pits or fissures, initial caries or enamel caries which were classified as having a score of 0-3 using the International Caries Detection and Assessment System (ICDAS) (Dikman, 2015) (Table 1). Parental consent was obtained from the parents of each subject prior to inclusion in this study.

Sealant application

The giomer sealant used in this study was BeautiSealant (Shofu, Kyoto, Japan) and the fluoride-releasing resin sealant used was Clinpro™ Sealant (3M™ ESPE™, 3M Canada, London Ontario, Canana). In each subject, one type of sealant was applied to the molars on one side of the mouth and the other type was applied to the molars on the other side of the mouth. The contralateral molars were matched so as to be in the same position on each side of the mouth.

The sealants were applied at the subjects respective schools by dentists with 5 years experience. Prior to application, the occlusal surfaces were cleaned using a rubber brush and pumice using a low-speed handpiece. Each tooth was isolated to ensure moisture control using a mouth gag, standard cotton rolls and a flexible plastic saliva ejector.

Each sealant was applied following the manufacturer's instructions. The molars were prepared for the resin sealant using 32% phosphoric acid (Scotchbond™ Univeral Etchant, 3M™ ESPE™, Canada) for 15 seconds, rinsed with water and dried. The etched surface of the molar was matte frosty white in appearance. The sealant was then applied using a syringe and cured with a curing LED light for 20 seconds. The contralateral molar was prepared for giomer sealant by applying a self-etched primer for 5 seconds and then the molar was dried without rinsing. The sealant was then applied with a syringe and light cured for 10 seconds.

After light curing, the molars were checked with an explorer to ensure no defects and occlusion was checked with articulating paper. Any problems were corrected at this time.

Evaluation

The clinical effectiveness of dental sealant defined as the ability to prevent dental caries and control dental caries progression included two main aspects: (1) sealant retention and (2) caries prevention. Sealant retention was evaluated as complete retention of sealant, partial loss of sealant and complete loss of sealant. (Simonsen, 1981). The second aspect was the ability to promote caries regression or prevent caries progression defined as a change in the ICDAS score at the re-exposed surface, where there was partial loss or total loss of sealant (Phonghanyudh *et al*, 2015). Caries prevention was defined as complete sealant retention, loss of sealant but no caries progession and loss of sealent with caries regression (Phonghanyudh *et al*, 2015).

The sealed teeth were checked at 1, 3, 6, 9, and 12 months for sealant retention, caries progression and caries regression where appropriate after removing debris and plaque using a dental explorer and mouth mirror. In the case of caries progression through the dentine and the care-

Table 1
The International Caries Detection and Assessment System (ICDAS) scoring system.

ICDAS score	Definition
0	Sound tooth surface; no change in enamel translucency after air drying for 5 seconds nor enamel hypoplasia.
1	Visual change seen in the enamel of pit or fissure areas after air drying.
2	Distinct visual changes seen in enamel when wet: white or colored, wider than the fissure/fossa.
3	Localized enamel breakdown without visible signs of dentinal involvement.

Table 2
Criteria for clinical effectiveness of sealant.

Type	Criteria
Retention	1. Complete retention of sealant 2. Partial loss of sealant 3. Complete loss of sealant
Caries transition	Caries transition at the re-exposed surface where there is partial loss or total loss of sealant 0. No change in caries No change in the ICDAS score compared to the baseline and complete retention of sealant 1. Caries regression A lower score than baseline 2. Caries progression A higher score than baseline

ICDAS, International Caries Decection and Assessment System.

giver was informed and recommended to bring the child to a dentist for treatment. At each visit subjects were examined and given a score (Table 2).

Statistical analysis

The data were recorded and analyzed using the Statistical Package for the Social Sciences for Windows, version 18 (IBM, Armonk, NY) and StatXact® for Windows, version 11 (Cytel, Cambridge, MA). The McNemar's test and Marginal Homogeneity Test For Ordered Tables were used to analyze differences in retention rates and caries prevention between the two studied sealants. A p-value<0.05 was considered statistically significant.

This study was performed following the ethical standards of the Helsinki Declaration and approved by the Faculty of Dentistry/Faculty of Pharmacy, Mahidol University, Institutional Review Board (CoA.No.MU-DT/PY-IRB 2016/063.2311).

RESULTS

One hundred forty subjects (78 males and 62 females) aged 2½ -5 (average: 4.4) years were included in the study. The

Table 3
The ICDAS score for studied molars in both group at baseline prior to treatment.

ICDAS scores	Resin group (*n*)	Giomer group (*n*)	*p*-value
0	7	8	0.631
1	17	18	
2	66	65	
3	26	25	
Total	116	116	

ICDAS, Intenational Caries Detection and Assessment System.

mean number of decayed, missing and filled teeth per subject was 2.7. Among the study subjects, the molars tested for sealant were 38 pairs of maxillary second primary molars and 102 pairs of mandibular second primary molars. Only 116 pairs (34 maxillary and 82 mandibular pairs) of molars were included in this analysis due to lack of follow-up throughout the study.

There was no significant difference ($p>0.05$) in the ICDAS scores between the subjects with the 2 types of sealant (Table 3). The retention of resin and giomer sealant is shown in Table 4. The resin sealant had a significantly higher retention rate than the giomer sealant ($p<0.05$). The numbers of teeth with partial loss of sealant, complete loss of sealant, caries regression and caries progression in both sealants groups are shown in Table 5. The fluoride releasing resin sealant was significantly ($p<0.05$) more effective at preventing caries than the giomer sealant (Table 6).

DISCUSSION

In this study we employed a "split-mouth" design, where we studied both sealant types in the same mouth, one on either side of the mouth. This method reduces confounding factors, such as dietary behavior, caries risk, and oral hygiene practices in children (Feigal *et al*, 2000; Lesaffre *et al*, 2009).

Our study subjects attended kindergartens. We examined the subjects at their schools using a mobile dental unit. The advantages of using a mobile dental unit are: accessibility to children in remote areas and examining the subjects in a familiar, comfortable environment to help them be more cooperative (Choomphupan, 2011; Vashishtha *et al*, 2014). However, in an uncontrolled environment, such as seen with a mobile dental unit, the level of oral moisture is not as easily controllable, and may be higher because of salivary contamination of the etched enamel, allowing more rapid formation of surface coatings, which may result in a decreased bond strength between the material and tooth surface, as described in several previous studies (Silverstone *et al*, 1985; Dijken, 1987). However, another study found no significant difference in sealant retention between using a cotton roll and a rubber dam during sealant application at 6 months after application (Poulsen and, Peltoniemi, 1979). In our study, we used cotton rolls and a mobile suction.

Our results show the resin sealant had a higher retention rate ($p<0.05$) than the giomer sealant. There are no previous published studies of the efficacy and retention of giomer sealant on primary teeth.

Table 4
Resin and giomer sealant retention at 1, 3, 6, 9 and 12 months post-application (n=116).

Sealant retention	Time of examination post-application in months									
	1		3		6		9		12	
	Resin *n* (%)	Giomer *n* (%)	Resin *n* (%)	Giomer *n* (%)	Resin *n* (%)	Giomer *n* (%)	Resin *n* (%)	Giomer *n* (%)	Resin *n* (%)	Giomer *n* (%)
Complete retention	112 (96.5)	85 (73.3)	101 (87.1)	37 (39.1)	89 (76.7)	22 (19.0)	87 (75.0)	19 (16.4)	84 (72.4)	17 (14.7)
Partial loss	4 (3.5)	27 (23.3)	14 (12.1)	54 (46.6)	25 (21.6)	49 (42.2)	25 (21.6)	49 (42.2)	26 (22.4)	48 (41.4)
Complete loss	0	4 (3.4)	1 (0.8)	25 (21.6)	2 (1.7)	45 (38.8)	4 (3.4)	48 (41.4)	6 (5.2)	51 (44.0)
p-value	<0.001		<0.001		<0.001		<0.001		<0.001	

Previous studies reported high retention rates with resin sealant (Simonsen, 1981; Hotuman *et al*, 1998; Vrbic, 1999). In our study, the resin sealant had 72.4% retention and the giomer sealant had 14.7% retention at 12 months. The lower retention rate of the resin sealant in our study than other studies is probably due to inadequate moisture control during sealant placement (Xie *et al*, 1993; Waggoner and Siegal, 1996; Celiberti and Lussi, 2007; Eliades *et al*, 2013; Mehrabkhani *et al*, 2015). Our study was performed in the field, while the other studies were performed in a dental office, which could have effected this difference. There may have been less moisture control with the mobile dental unit. Hotuman *et al* (1988) reported the retention of light polymerised (PrismaShield®) and autopolymerised (Delton®) resin sealant at a municipal dental clinic at 2.8 years to be 76.5% and 70.6%, respectively. Simonsen (1981) and Vrbic (1999) reported the retention rates of resin sealant at 3 years to be 94.6% and 95.04%, respectively. We believe the moisture control in our study was the primary factor that resulted in lower retention rates compared to other studies.

Ganesh and Tandon (2006) found no significant difference in sealant retention between resin and glass ionomer sealant at one-year, but found the resin had a significantly higher retention rate at two years. However, Phonghanyudh *et al* (2015) found a significantly higher resin sealant retention rate than glass ionomer retention rate at one-year.

Enamel preparation is a major factor associated with sealant microleakage and retention (Perry and Rueggeberg, 2003). In our study, following the manufacturer's instructions, the resin sealant was applied after phosphoric acid etching

Table 5
Caries status of the studied molars by sealant type overtime.

Sealant type	Months after sealent application	*n*	No change *n* (%)	Caries regression *n* (%)	Caries progression *n* (%)
Resin	1	4	4 (100)	0	0
	3	15	6 (40)	7 (46.6)	2 (13.4)
	6	27	6 (22.2)	14 (51.9)	7 (25.9)
	9	29	8 (27.6)	13 (44.8)	8 (27.6)
	12	32	10 (31.3)	13 (40.6)	9 (28.1)
Giomer	1	31	24 (77.4)	6 (19.4)	1 (3.2)
	3	79	43 (54.4)	31 (39.3)	5 (6.3)
	6	94	31 (32.9)	47 (50.0)	16 (17.1)
	9	97	31 (31.9)	46 (47.4)	20 (20.7)
	12	99	29 (29.3)	47 (47.5)	23 (23.2)

and the giomer sealant was applied after using a self-etch primer. In our study, the resin had better retention than the giomer sealant. Our study was performed *in vivo*. Previous studies have only been performed *in vitro*. Shimazu *et al* (2012) found giomer sealant (BeautiSealant) prepared by self-etching primer was not significantly different from a resin-based sealant prepared by acid etching (Delton and Teethmate F-1) in bovine incisors. Our study also found the giomer sealant with self-etching primer maintained the integrity of unbonded enamel.

Sealant retention is important, but the ultimate goal is caries prevention. Phonghanyudh *et al* (2015) reported no difference in caries prevention between resin and glass ionomer. Both sealants gave more than 90% caries prevention in primary molars for 12 months, similar to the results seen with the resin sealant found in our study (92.2%), but greater than the results seen with the giomer sealant in our study (80.2%).

Caries prevention may result from the ion releasing and recharging properties and the antibacterial effect of the sealants (An *et al*, 2015). Previous studies (Shimazu *et al*, 2011; Salmeron-Valdes *et al*, 2016) compared the ion releasing and recharging ability of giomer sealant with resin sealant and found the giomer sealant had greater ion releasing and recharging properties than the resin sealant; this may induce remineralization and result in caries prevention.

In our study, the giomer sealant caused caries regression at the surface in spite of partial or total loss of sealant. A possible reason for this may be the antibacterial properties of giomer sealant. An *et al* (2015) avaluated the antibacterial properties of giomer sealant and found it released fluoride ions which interfered with bacterial metabolism. Giomer sealant has also been found to release strontium (Sr) and boron (B) that inhibit bacterial growth.

The limitations of this study included the 1 year follow-up period and the fact that subjects were also treated with fluoride vanish effecting caries. However, the split-mouth design still enables compari-

Table 6
Sealant retention and caries status over time by sealant type.

Months after sealant applicant n=116	Resin group n (%)				Giomer group n (%)				p-value
	Complete sealant retention	Re-exposed teeth		Caries prevention	Complete sealant retention	Re-exposed teeth		Caries prevention	
		No change	Caries regression			No change	Caries regression		
1	112 (96.6)	4 (3.4)		116 (100)	85 (73.2)	24 (20.7)	6 (5.2)	115 (99.1)	
3	101 (87.1)	6 (5.2)	7 (6)	114 (98.3)	37 (31.9)	43 (37.1)	31 (26.7)	111 (95.7)	0.453
6	89 (76.7)	6 (5.2)	14 (12.1)	109 (94)	22 (19)	31 (26.7)	47 (40.5)	100 (86.2)	0.064
9	87 (75)	8 (6.9)	13 (11.2)	108 (93.1)*	19 (16.4)	31 (26.7)	46 (39.7)	96 (82.8)[a]	0.017[a]
12	84 (72.4)	10 (8.6)	13 (11.2)	107 (92.2)*	17 (14.7)	29 (25)	47 (40.5)	93 (80.2)[a]	0.007[a]

[a]$p < 0.05$.

sons between the two sealants.

The results of our study demonstrate the resin sealant is superior to giomer sealant in retention and, more importantly, in caries prevention. Further studies are needed comparing giomer sealant with glass ionomer sealant to determine if giomer sealant should be considered at all as second or the third line treatment for children who are not good candidates for resin sealant. Results from our current study suggested giomer sealant is not appropriate for children who can tolerate resin sealant, and that giomer sealant cannot be recommended in any circumstances until it is compared with glass ionomer sealant *in vivo*.

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