Glass ionomer sealant versus fluoride varnish in preventing occlusal caries among preschool children: a randomised controlled trial (abridged secondary publication)

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KEY MESSAGES

1. Both the quarterly application of sodium fluoride varnish and a single placement of glass ionomer sealant were equally effective in preventing occlusal caries in primary second molars over 24 months.
2. Placement of glass ionomer sealant was more cost-effective in preventing occlusal caries within 24 months.
3. Caries experience and incipient occlusal lesions increased the likelihood of caries progression into dentine in primary second molars.

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Introduction

Early childhood caries affects preschool children worldwide. The occlusal surface of primary molars is highly susceptible to caries. Fluoride varnish (FV) and fissure sealants are effective in preventing occlusal caries in primary molars. FV inhibits caries in both primary and permanent teeth[1] and requires reapplication every 3 to 6 months. Fissure sealants prevent occlusal caries in permanent molars. Resin-based sealants and glass ionomer sealants (GISs) act as barriers by sealing occlusal pits and fissures, thus reducing plaque retention. GISs also release fluoride over time, providing additional caries prevention for both treated and adjacent teeth. A Cochrane review found that fissure sealants were more effective than FV in preventing caries in permanent molars.[1] Fissure sealants have shown effectiveness in permanent molars among school-aged children.[2] However, fissure sealant application in younger children is technique-sensitive. GIS can bond to enamel and is moisture-tolerant, making it suitable for use in young patients and in outreach settings. This study aimed to determine the relative effectiveness and costs of sodium FV and GIS in preventing occlusal caries in the primary molars of preschool children.

Methods

Preschool children from 16 kindergartens were invited to participate. They were examined by a calibrated dentist using the Visible Plaque Index, dmft (the number of decayed, missing due to caries, and filled teeth), and ICDAS (International Caries Detection and Assessment System) scores. Participants were randomly assigned to receive either sodium FV or GIS. Oral health behaviours, dental history, and socioeconomic background were recorded via questionnaire. Children in the sodium FV group were recalled at months 3, 6, 9, 12, 15, 18, 21, and 24 for reapplication. Follow-up examinations were conducted at months 6, 12, 18, and 24 by the same examiner. A 10% random sample was re-examined to assess reproducibility. Sealant retention and caries development in primary second molars (PSMs) were evaluated.

Results

In total, 413 eligible children were included in the analysis. They were randomly assigned to either the sodium FV group (n=228, 845 PSMs) or the GIS group (n=185, 665 PSMs). Overall, 112 PSMs were excluded due to existing caries, prior restorations, partial eruption, non-compliance, strong gag reflex, or difficulty in achieving a dry field. Dropout rates at various intervals did not significantly differ between groups. Children more likely to be lost to follow-up at 24 months were older ($P<0.001$), had older parents ($P=0.018$), and came from higher-income households ($P<0.001$).

Cohen's kappa values for intra-examiner reliability were 0.774 for the Visible Plaque Index, 0.964 for dmft, and 0.834 for ICDAS II scores. At 24 months, caries development on the occlusal surface was observed in 18.3% of the sodium FV group and

17.7% of the GIS group. Of all PSMs, 22.3% and 20.7% developed dentinal caries in the respective groups. The two groups were comparable in terms of occlusal caries prevention (Table 1). GIS survival rates declined over time, reaching 4.4% at 24 months. Partial GIS retention resulted in dentinal caries in 1% of molars at 24 months. Dislodged GIS led to dentinal caries in 5.1%, 13.6%, 11.1%, and 16.7% of molars at 6, 12, 18, and 24 months, respectively (Table 2). Regression analyses showed that incipient occlusal caries lesions and higher baseline dmft scores significantly increased the likelihood of developing dentinal caries after 24 months. The overall direct costs for delivering sodium FV and GISs in kindergarten settings were HK$61.9 and HK$28.0 over 24 months, respectively. GIS was significantly less costly over 24 months.

Discussion

Both a single placement of GIS and quarterly application of sodium FV were effective in preventing occlusal caries in PSMs after 24 months. GIS placement was significantly less costly; however, GIS retention rates among preschool children were low at 24 months, limiting the effectiveness of occlusal caries prevention. This low retention rate may be attributed to shallow fissures, low compliance, and difficulties in achieving a dry field. The viscosity of GISs affect their clinical efficacy and retention. High-viscosity GISs may perform better. The present study used a medium-viscosity GIS, which may not be ideal for young children in outreach settings.

The present study did not implement measures to improve children's oral hygiene, which may explain the continued progression of dental caries despite preventive interventions. In Hong Kong, preschool children have access to fluoridated water and toothpaste; therefore, additional benefits from sodium FV and GIS may be limited. The importance of oral health education before implementing interventions is emphasised because baseline caries experience and early signs of decay are key factors for caries development.

Few studies have compared the cost-effectiveness of sealants and FV.[3,4] GIS appears more favourable because of a single application. However, its low retention rates diminishes its cost-effectiveness. In China, sealants yield similar caries prevention outcomes at 24 months but are associated with higher costs.[3] In Brazil, sealants are more cost-effective at 24 months but not at 48 months for high-risk children.[4] Providers may consider integrating FV application with infant vaccination schedules to reduce indirect dental and opportunity costs. In Thailand, such integration significantly improves the cost-effectiveness of FV.[5] The cost of applying sodium FV could also be reduced by involving dental hygienists or dental therapists rather than dentists. Further research is needed to better understand the cost-effectiveness of sealants compared with FV.

Conclusion

Quarterly application of sodium FV and single-placement GIS demonstrated similar efficacy in preventing occlusal caries in PSMs over 24 months; the GIS was less expensive. Baseline caries status and incipient occlusal caries were associated with an increased risk of occlusal caries progression in PSMs.

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TABLE 1. Incidence of dentinal caries on the occlusal surfaces and all surfaces of primary second molars (PSMs) over 24 months.

Dentinal caries	Baseline (n=1510)*		6 months (n=1170)*		12 months (n=1282)*		18 months (n=712)*		24 months (n=698)*		Intragroup comparisons	
On occlusal surfaces (ICDAS score ≥4)												
All included PSMs	n=1510	0	n=1170	70 (6.0)	n=1282	171 (13.3)	n=712	81 (11.4)	n=698	126 (18.1)	n=509	P<0.001
Sodium fluoride varnish	n=845	0	n=676	47 (7.0)	n=721	91 (12.6)	n=405	66 (16.3)	n=404	74 (18.3)	n=291	P<0.001
Glass ionomer sealant	n=665	0	n=494	27 (5.5)	n=561	80 (14.3)	n=307	38 (12.4)	n=294	52 (17.7)	n=218	P<0.001
		-		P=0.302		P=0.392		P=0.143		P=0.831		
On PSM (ICDAS score ≥4)												
All included PSMs	n=1510	0	n=1170	96 (8.2)	n=1282	217 (16.9)	n=712	133 (18.7)	n=698	151 (21.6)	n=509	P<0.001
Sodium fluoride varnish	n=845	0	n=676	60 (8.9)	n=721	118 (16.4)	n=405	81 (20.0)	n=404	90 (22.3)	n=291	P<0.001
Glass ionomer sealant	n=665	0	n=494	36 (7.3)	n=561	99 (17.6)	n=307	52 (16.9)	n=294	61 (20.8)	n=218	P<0.001
		-		P=0.328		P=0.544		P=0.299		P=0.612		

Abbreviation: ICDAS=International Caries Detection and Assessment System

* Data are presented as No. (%) of PSMs unless otherwise indicated

TABLE 2. Glass ionomer sealant retention and caries occurrence on the occlusal surfaces of primary second molars (PSMs) over 24 months.

Outcome	Tooth 55*	Tooth 65*	Tooth 75*	Tooth 85*	All included PSMs*	P value (sealant retention)	P value (caries occurrence)
6 months	n=123	n=122	n=125	n=124	n=494	0.246	0.653
Sealant lost without caries	98 (79.7)	100 (82.0)	86 (68.8)	92 (74.2)	376 (76.1)		
Sealant retained fully or partially without caries	21 (17.1)	15 (12.3)	31 (24.8)	24 (19.4)	91 (18.4)		
Sealant retained fully or partially with dentinal caries	0	0	1 (0.8)	1 (0.8)	2 (0.4)		
Decayed with dentinal caries or filled	4 (3.3)	7 (5.7)	7 (5.6)	7 (5.7)	25 (5.1)		
12 months	n=139	n=139	n=143	n=140	n=561	0.008	0.951
Sealant lost without caries	115 (82.7)	133 (81.3)	104 (72.7)	112 (80.0)	444 (79.1)		
Sealant retained fully or partially without caries	4 (2.9)	8 (5.8)	17 (11.9)	8 (5.7)	37 (6.6)		
Sealant retained fully or partially with dentinal caries	0	0	4 (2.8)	0	4 (0.7)		
Decayed with dentinal caries or filled	20 (14.4)	18 (13.0)	18 (12.6)	20 (14.3)	76 (13.6)		
18 months	n=76	n=75	n=77	n=79	n=307	0.003	0.329
Sealant lost without caries	65 (85.5)	62 (82.7)	60 (77.9)	64 (81.0)	251 (81.8)		
Sealant retained fully or partially without caries	1 (1.3)	2 (2.7)	12 (15.6)	3 (3.8)	18 (5.9)		
Sealant retained fully or partially with dentinal caries	1 (1.3)	1 (1.3)	2 (2.6)	0	4 (1.3)		
Decayed with dentinal caries or filled	9 (11.8)	10 (13.3)	3 (3.9)	12 (15.2)	34 (11.1)		
24 months	n=73	n=72	n=73	n=76	n=294	0.039	0.990
Sealant lost without caries	61 (83.6)	59 (81.9)	53 (72.6)	59 (77.6)	232 (78.9)		
Sealant retained fully or partially without caries	0	0	7 (9.6)	3 (4.0)	10 (3.4)		
Sealant retained fully or partially with dentinal caries	0	1 (1.4)	2 (2.7)	0	3 (1.0)		
Decayed with dentinal caries or filled	12 (16.4)	12 (16.7)	11 (15.1)	14 (18.4)	49 (16.7)		

* Data are presented as No. (%) of PSMs

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Disclosure

The results of this research have been previously published in:

1. Lam PP, Sardana D, Lo EC, Yiu CK. Fissure sealant in a nutshell. Evidence-based meta-evaluation of sealants' effectiveness in caries prevention and arrest. J Evid Based Dent Pract 2021;21:101587.
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4. Lam P, Chu H, Lo E, Yiu C. Patient-reported outcomes towards minimal intervention dentistry in preventing occlusal caries among preschool children. A randomized controlled trial. Int J Paediatr Dent 2023;33(S1):182.

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