



# Dental sealants

## Material-related clinical outcomes

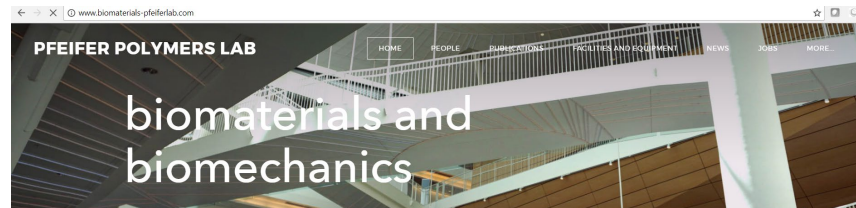
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PRESENTED BY: Carmem Pfeifer, DDS, PhD, Professor, Division Head

# Carmem Pfeifer, DDS, PhD

- DDS 2001 – 8 years of clinical practice – special needs patients
- PhD 2007 – Dental Materials (post-doc in polymer chemistry)
- Professor, Division Head of Biomaterial and Biomedical Sciences - at OHSU since 2011
- Fellow of the Academy of Dental Materials
- NIH-NIDCR funded since 2013

# OHSU-SOD – faculty since 2011



# Outline

- Available materials
- Best practices for placement
- Outcomes assessment

# Sealants – general statements

- Two main types: resin-based and glass ionomer-based
- Placement technique influences outcomes; some materials are more technique-sensitive than others
- Outcomes are assessed in terms of **retention** – measured with some set of clinical criteria (Simonsen's criteria/scale, for example) - and or **caries reduction**.

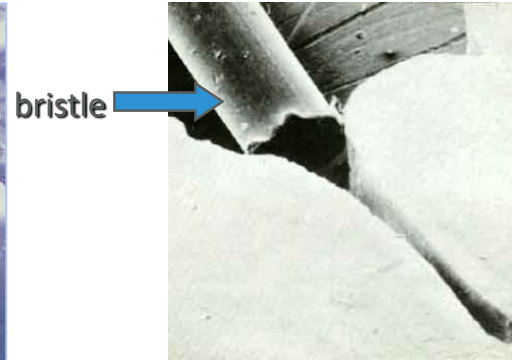
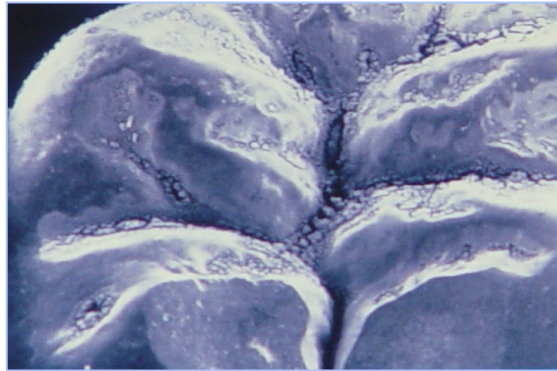
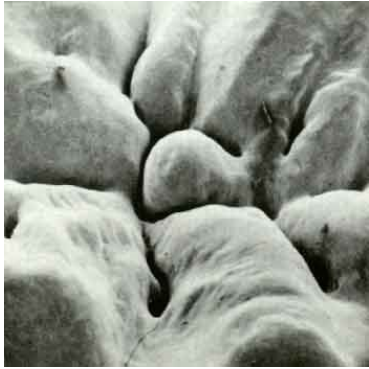


MYTHBUSTERS

# MythBusters

- Sealants should only be placed on sound enamel

# Anatomical considerations



- Pits and fissures vary wildly
- Partially-erupted teeth





# Sealing non-cavitated lesions

Table 2. Caries incidence in the occlusal surfaces of permanent first molars for the experimental and control groups, after 36 months clinical evaluation.

Group	6 months Decay + filled (%)	12 months Decay + filled (%)	24 months Decay + filled (%)	36 months Decay + filled (%)
Experimental Ketac-Bond	2 (1.0)	7 (3.9)	24 (13.1)	27 (15.7)
Experimental Vitremer	2 (1.0)	7 (3.9)	17 (9.9)	20 (11.6)
Experimental	4 (1.0 <sup>b</sup> )	14 (3.9 <sup>b</sup> )	41 (12.0 <sup>b</sup> )	47 (13.6 <sup>a</sup> )
Control	58 (14.8 <sup>a</sup> )	68 (17.6 <sup>a</sup> )	90 (23.7 <sup>a</sup> )	110 (31.2 <sup>a</sup> )

<sup>a</sup> Groups with letters a and b show significant difference ( $P \leq 0.05$ ).

**Glass ionomer and resin-based sealants are effective in arresting caries in non-cavitated lesions**



Pre-Sealant  
ICDAS 4; x-ray D1  
Diagnodent 92

Post-Sealant (12-months)  
ICDAS 4; x-ray D1  
45

Post-Sealant (24-months)  
ICDAS 4; x-ray D1  
59

Post-Sealant (32-months)  
ICDAS 4; x-ray D1  
52

- Pereira AC, Pardi V, Mialhe FL, Meneghim Mde C, Ambrosano GM. A 3-year clinical evaluation of glass-ionomer cements used as fissure sealants. *Am J Dent* 2003;16(1):23-7.
- Lam, P.P., Sardana, D., Lo, E.C., Yiu, C.K. (2021) *Journal of Evidence-Based Dental Practice*, 21 (3), art. no. 101587
- Fontana, M: *Management of Deep Carious Lesions* (book chapter) Pages 93 – 112, January 2018
- And many more

# MythBusters

- Sealants should be placed on sound





MYTHBUSTERS

# MythBusters

- Only replace sealants if they are not visible without magnification

# Resin-based sealants

- Composition
  - Dimethacrylate monomers (plastics) – water repellent
    - (“hydro” compositions available)
  - Initiators/pigments
  - Inorganic fillers (not all of them)
  - Fluoride – few examples, not efficacious in terms of release
- A few commercial examples:



# Placement technique

- Retention mechanism: micromechanical interlocking



Etch/rinse  
**DRY**



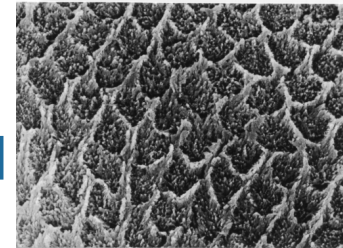
Obtain micro -  
mechanical  
interlocking –  
avoid  
contamination  
by saliva



Photocure



Apply adhesive  
(if required)  
Apply sealant  
(brush, applicator or  
tip of explorer)



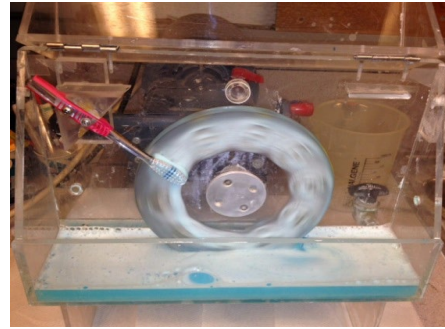
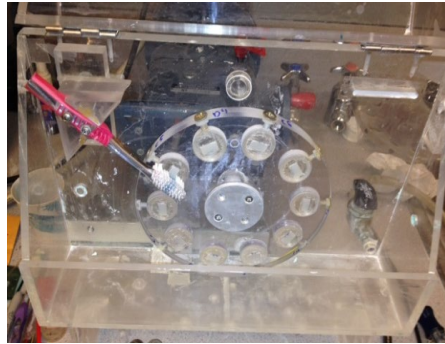
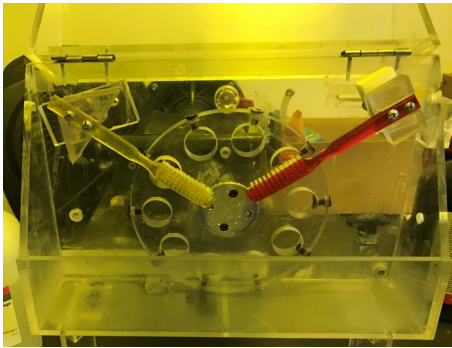
**Bottom line: retention depends heavily on moisture control**

# Placement technique

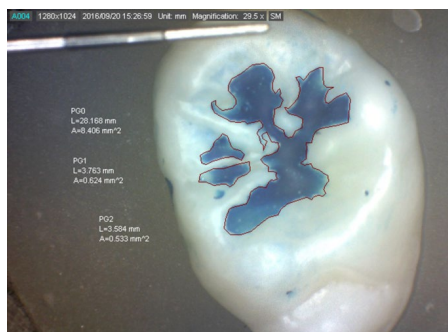
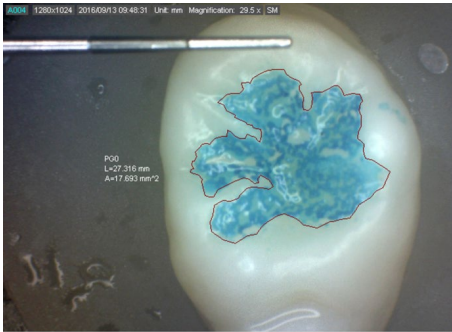


# Pediatric resident research at OHSU

- Testing the retention of resin sealants in vitro



Simulated  
toothbrushing  
wear



All teeth retained some of  
the sealant, but the surface  
coverage decreased with  
toothbrushing simulation

Picture: Dr. Steven Kirby, pediatric resident





# Potential problems

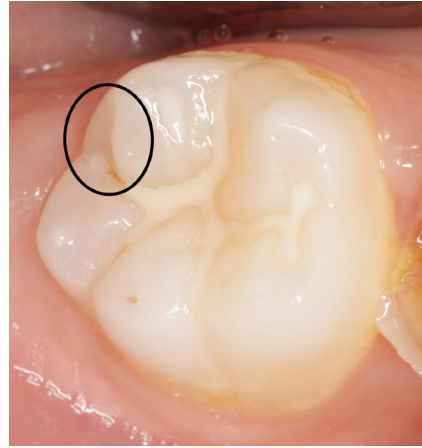
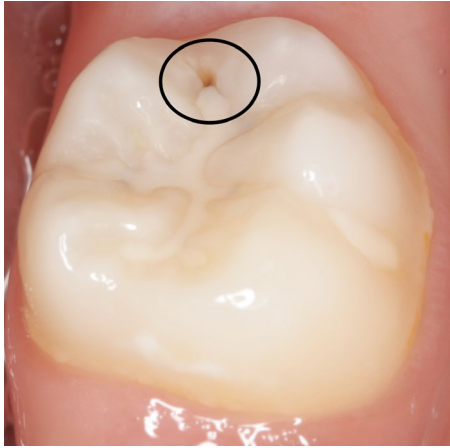
- Even when there is retention, the sealant might be infiltrated from the bottom



Resin sealants placed by pediatric residents following manufacturer's instructions (Ultra-seal)  
Teeth cycled in toothbrushing machine – simulating 1 year of brushing  
Sealants stained with methylene blue – infiltration measured under 20x

Picture: Dr. Steven Kirby, pediatric resident

# Replacing sealants: when and why?



Tianviwat S, Emerging Trends in Oral Health Sciences and Dentistry (book chapter, DOI: 10.5772/59516, 2015)

**Presence of caries, and not retention, is the criterion for sealant replacement**



8 years



12 years



17 years



19+ years

Simonsen RJ et al, Australian Dental Journal, Volume 56, Issue SUPPL. 1, Pages 45 - 58 June 2011

# MythBusters

- Only repla... are not visible...ification



# Resin-based sealants

## Advantages

- Relatively stable (for highly hydrophobic compositions)
- Good wear resistance
- Esthetic
- Easy to visualize

## Disadvantages

- Sensitive placement technique – requires DRY field
- Viscosity concern for some brands – recommend the use of surface primers (diluted sealant)
- May conceal microleakage – secondary decay under the sealant if poorly bonded



MYTHBUSTERS

# MythBusters

- Fluoride release from GI sealants is only significant if the sealant is visible on the surface without magnification

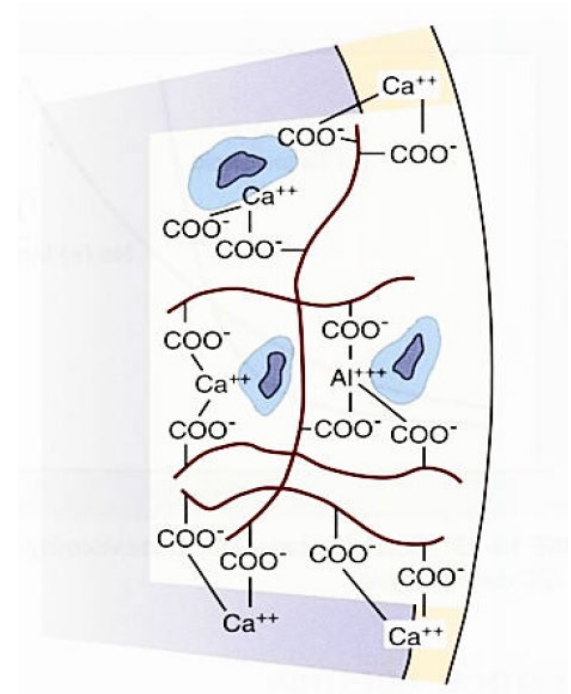
# Glass-ionomer sealants

- Composition
  - Conventional: **polyacrylic acid, water** and aluminum/calcium fluoride powder
  - Resin-modified (RMGI): conventional + **hydroxyethyl methacrylate** (HEMA – photoactivated on command)
- Commercial examples



# Glass-ionomer sealants

- Retention mechanism: ionic interaction with tooth surface (chelation of mineral content)
- $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{AlF}_3$ ,  $\text{CaF}_2$ ,  $\text{NaF}$  are dissociated in **WATER**
- Polyatomic ions serve as **crosslinkers** with polyacrylic acid and the **mineral content** in the tooth
- HEMA allows for cure on command – overcomes imbibition/syneresis concerns



**Bottom line: retention is less dependent on moisture control**



# Placement technique

C

ART SEALANT



CLEANING



CONDITIONING  
POLYACRILIC ACID



RINSING



DRYING



APPLYING THE GLASS-IONOMER



PRESSING THE MATERIAL



SEALED PIT AND FISSURE

Leal, Moreira and Imparato – *Dental Sealants in Pediatric Restorative Dentistry (chapter 8)*

# COVID 19 considerations - placement

## Resin-based

- Resin sealant or RMGIC
- Aerosol from acid etch rinsing/drying
- Requires photocuring (one extra piece of equipment for potential cross-contamination)

## ART

- Conventional GIC
- Conditioner does not need to be rinsed with water jet
- All placement materials can be single-use (disposable)

# Glass-ionomer sealants

## Advantages

- Fluoride-release – favors remineralization. After burst release, fluoride is still detected for as long as a few years
- Lower viscosity – deep penetration in fissures
- Adhesion is ionically-based – not as sensitive to placement technique
- Resin-modified types address some disadvantages

## Disadvantages

- Sensitive to imbibition and synerisis after placement
- Poor wear-resistance – though retention in areas free of abrasion (i.e., deep in the fissures) is excellent
- Opaque – poor esthetics

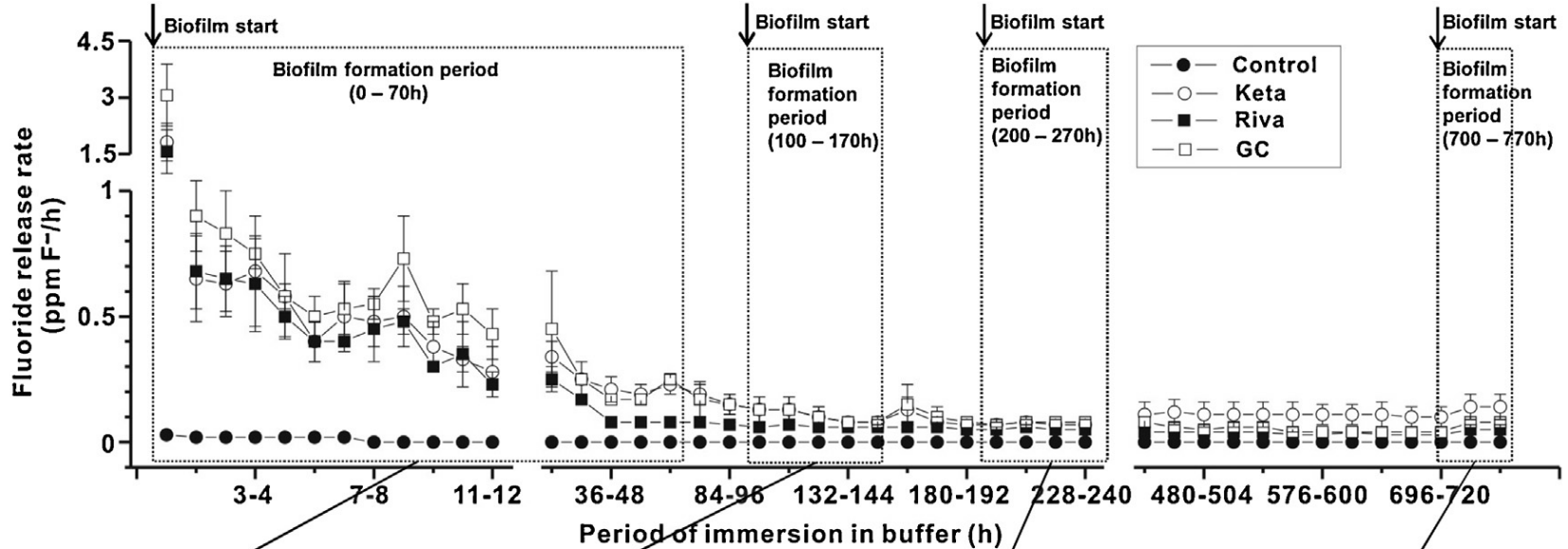
Koch, Swed Dent J. 1990;14(6):267-73

Koch, Swed Dent J. 1991;15(6):253-8

Mousavinasab, Dent Res J (Isfahan). 2009 Autumn; 6(2): 75–81



# Fluoride release – in vitro



70-h-old *S. mutans* biofilm formation on G-I discs immersed in buffer for 0 h (0 day)

70-h-old *S. mutans* biofilm formation on G-I discs immersed in buffer for 100 h (4.2 days)

70-h-old *S. mutans* biofilm formation on G-I discs immersed in buffer for 200 h (8.3 days)

70-h-old *S. mutans* biofilm formation on G-I discs immersed in buffer for 700 h (29.2 days)

**Conclusion on long-term anti-cariogenic biofilm activity of glass ionomers related to fluoride release**



# MythBusters

- Fluoride releasing sealants is only seen if the sealant is visible on the surface without magnification





MYTHBUSTERS

# MythBusters

- GI is an inferior and only an interim sealant rather than a more permanent resin sealant

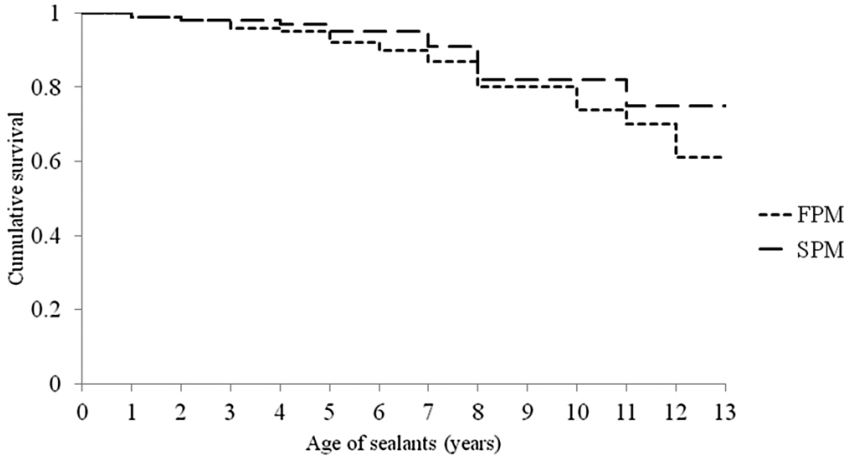
# Outcomes assessment

- Recent literature review (2018 or more recent)
- *In vitro* and clinical studies
- Retention and caries formation



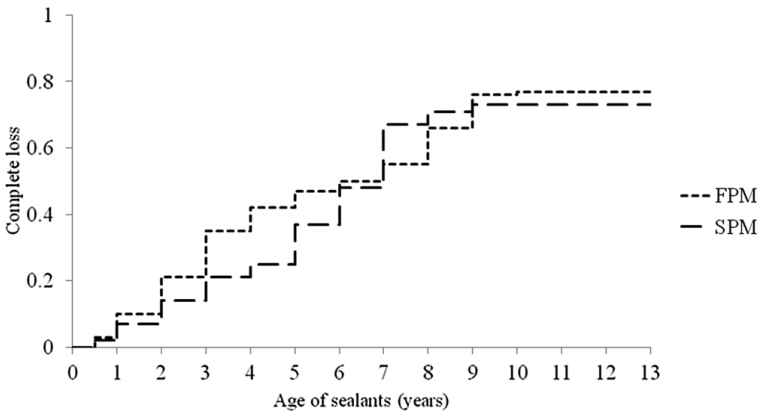


# Glass ionomer



## Glass-ionomer fissure sealants: Clinical observations up to 13 years

Dejan Markovic<sup>a</sup>, Tamara Peric<sup>a,\*</sup>, Bojan Petrovic<sup>b</sup>



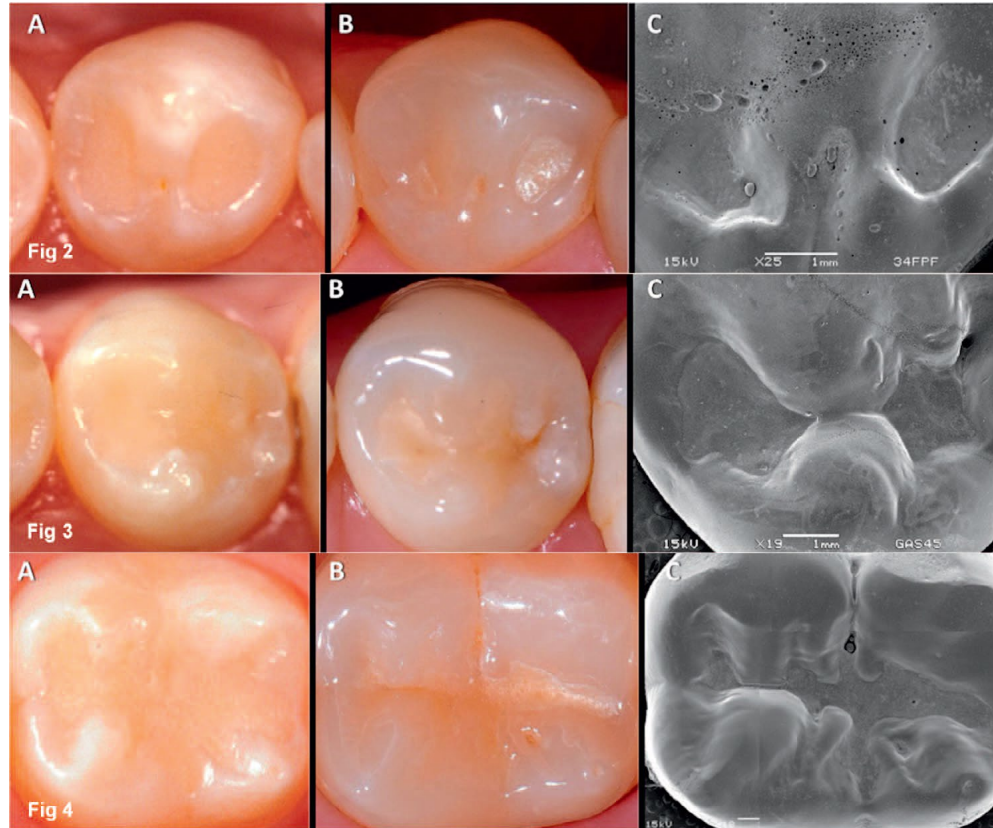
**Conclusions:** Although the retention rate of the glass-ionomer material for fissure sealing was low, it appears to have prevented dental caries in 65% of newly erupted permanent molars evaluated after thirteen years of placement.



# RMGIC retention – 22 year clinical follow up

- Vitrebond or Fuji II LC

**Conclusions:** Materials were at least partially retained and teeth were caries-free after 22 years clinical follow up



# Resin-based sealant



**Cochrane  
Library**

Cochrane Database of Systematic Reviews

## **Pit and fissure sealants for preventing dental decay in permanent teeth (Review)**

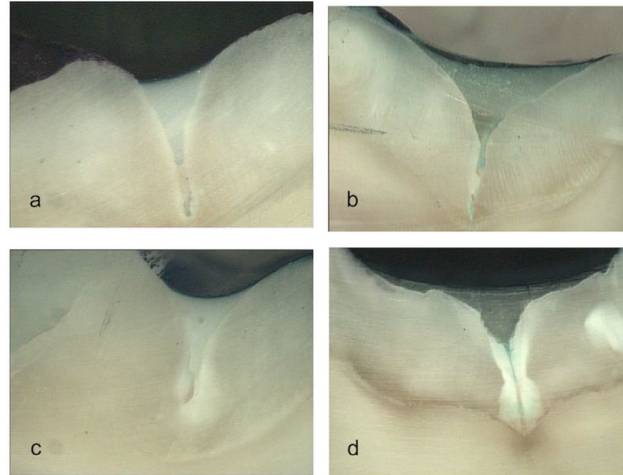
Ahovuo-Saloranta A, Forss H, Walsh T, Nordblad A, Mäkelä M, Worthington HV

### **Authors' conclusions**

Resin-based sealants applied on occlusal surfaces of permanent molars are effective for preventing caries in children and adolescents. Our review found moderate-quality evidence that resin-based sealants reduced caries by between 11% and 51% compared to no sealant, when measured at 24 months.

# Comparative analyses

**Citation:** Germán-Cecilia C, Gallego Reyes SM, Pérez Silva A, Serna Muñoz C, Ortiz-Ruiz AJ (2018) Microleakage of conventional light-cure resin-based fissure sealant and resin-modified glass ionomer sealant after application of a fluoride varnish on demineralized enamel. PLoS ONE 13 (12): e0208856. <https://doi.org/10.1371/journal.pone.0208856>



RESEARCH ARTICLE

Microleakage of conventional light-cure resin-based fissure sealant and resin-modified glass ionomer sealant after application of a fluoride varnish on demineralized enamel

Concepción Germán-Cecilia<sup>1,2\*</sup>, Sandra María Gallego Reyes<sup>1</sup>, Amparo Pérez Silva<sup>1</sup>, Clara Serna Muñoz<sup>1</sup>, Antonio José Ortiz-Ruiz<sup>1</sup>

## Authors' conclusions

There was no difference in microleakage between RB and GIC sealants after 20 day incubation in artificial saliva at body temperature.

Table 2. Percent microleakage.

Group	Enamel	Sealant	± SD (%)	
1	Intact	GrandiO Seal	3.20 ± 1.34	a
2	Intact	Vitremer	3.90 ± 1.23	a
3	Demineralized	GrandiO Seal	3.29 ± 2.02	a
4	Demineralized	Vitremer	2.92 ± 1.16	a



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journal homepage: [www.elsevier.com/locate/jdent](http://www.elsevier.com/locate/jdent)

# Comparative analyses

Retention and remineralization effect of moisture tolerant resin-based sealant and glass ionomer sealant on non-cavitated pit and fissure caries: Randomized controlled clinical trial

Laith Alsabek<sup>a</sup>, Zuhair Al-Nerabieah<sup>b</sup>, Nada Bshara<sup>b</sup>, John C. Comisi<sup>c,\*</sup>

**Table 4**  
Comparison of sealant retention rates. **A: Embrace™ WetBond™**  
**B: Fuji TRIAGE®**

Evaluation	Sealant retention	Group A (n = 40), n = (%)	Group B(n = 40), n = (%)	Significant
<b>3 months</b>	full retention	38 (95)	35 (87.5)	P = 0.216
	Partial retention	2 (5)	2 (5)	
	full loss	0 (0)	3 (7.5)	
<b>6 months</b>	full retention	34 (85)	25 (62.5)	P = 0.04*
	Partial retention	2 (5)	7 (17.5)	
	full loss	4 (10)	8 (20)	

\* Significantly different (P < 0.05).

## Conclusion

RB and GIC sealants showed similar retention at 3 months, but at 6 months, RB sealants had statistically greater retention

# Comparative analyses

## Retention rates and caries-preventive effects of two different sealant materials: a randomised clinical trial

Renata Nunes Cabral<sup>1</sup> · Jorge Faber<sup>1</sup> · Simone Auxiliadora Morais Otero<sup>1</sup> · Leandro Augusto Hilgert<sup>1</sup> · Soraya Coelho Leal<sup>1</sup>

### Clinpro XT Varnish (CXT) or Fuji IX GP FAST (FJ)

**Table 2** Cumulative survival rates (%) and standard errors (SE) of sealants retained in occlusal surfaces at 6, 12 and 24 months

Interval	Traditional categorisation		Modified categorisation	
	FJ % (SE)	CXT % (SE)	FJ % (SE)	CXT % (SE)
6 months	97.3 (1.2)	97.4 (1.2)	87.8 (2.5)	80.7 (3.3)
12 months	91.5 (2.0)	91.0 (2.1)	80.2 (3.0)	63.4 (4.0)
24 months	69.1 (4.5)	44.4 (5.0)	40.1 (5.1)	11.3 (3.7)
	Over 2 years $p = 0.005^*$		Over 2 years $p = 0.001^*$	

\*The difference between survival curves was determined by the log-rank test

**Table 3** Cumulative survival rates (%) and standard errors (SE) of dentine-caries-free occlusal surfaces at 6, 12 and 24 months

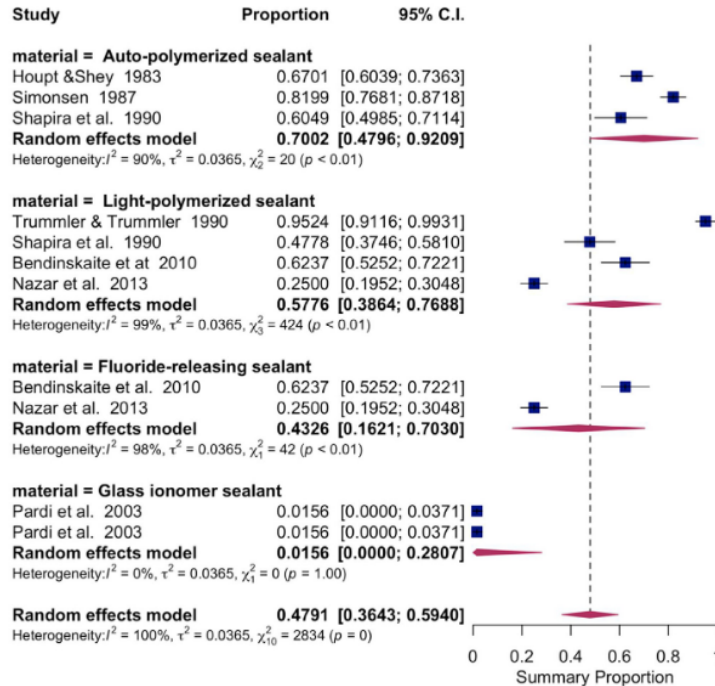
Interval	Clinical evaluation	
	FJ % (SE)	CXT % (SE)
6 months	100 (0.0)	99.5 (0.5)
12 months	99.5 (0.5)	99.5 (0.5)
24 months	98.3 (1.3)	98.3 (5.0)
	Over 2 years $p = 0.994^{**}$	

\*\*The difference between survival curves was determined by the log-rank test

### Conclusion

Both materials were equally effective in preventing the development of cavitated dentine lesions, although sealants prepared with high-viscosity GIC survived longer than those prepared with modified GIC.

# Comparative analyses



## Meta-analysis of the longevity of commonly used pit and fissure sealant materials

Jan Kühnisch<sup>a,\*</sup>, Ahmed Bedir<sup>a,b</sup>, Yi-Fang Lo<sup>a</sup>, Andreas Kessler<sup>a</sup>,  
Toni Lang<sup>a</sup>, Ulrich Mansmann<sup>b</sup>, Roswitha Heinrich-Weltzien<sup>c</sup>,  
Reinhard Hinkel<sup>a</sup>

### Conclusion

Retention of GIC sealants is poorer than resin-based sealants

# MythBusters

- GI is an inf...  
interior... than a more  
permanent resin sealant





# Take home message




- Resin-based sealants are effective as long as they are placed under DRY conditions
- Retention is greater for RB sealants compared with GIC, but the caries prevention is similar
- GIC and especially RMGIC are far less sensitive to moisture conditions – water is in their composition

# Take home message



- Fluoride release decreases over time, and there is conflicting evidence as to the possibility for re-charge
- RMGIC can be photoactivated and achieve most of their strength right away. Resin portion also protects material from imbibition and dessication after placement
- Systematic reviews and prospective studies demonstrate both types of materials are effective



“Under less than optimal conditions, the least technique-sensitive material may bring advantages”



Thank You

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