OHSU

Dental sealants

Material-related clinical outcomes

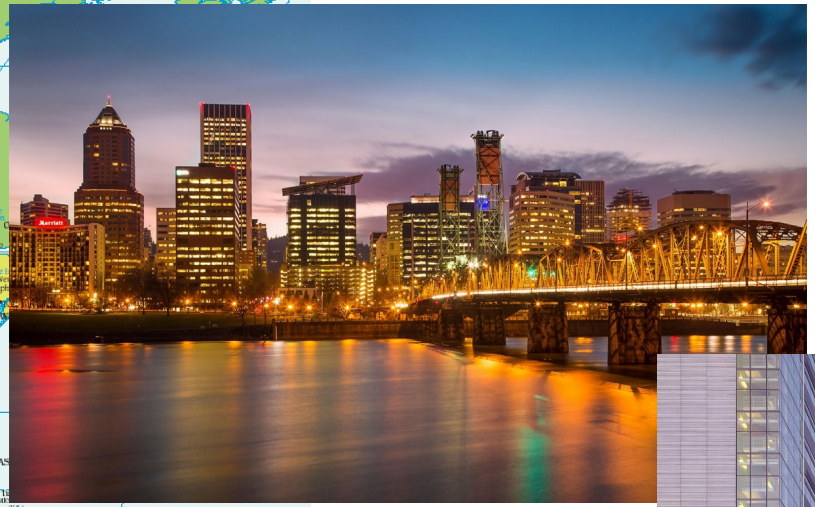
DATE: August 7, 2020 PRESENTED BY: Carmem Pfeifer, DDS, PhD, Associate Professor

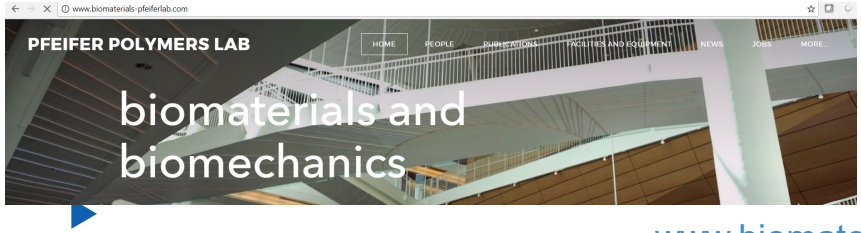
Carmem Pfeifer, DDS, PhD

- DDS 2001 – 8 years of clinical practice – special needs patients
- PhD 2007 – Dental Materials (post-doc in polymer chemistry)
- Associate professor at OHSU since 2011 – course director for Dental Materials disciplines
- Fellow of the Academy of Dental Materials
- NIH-NIDCR funded since 2013

OHSU

OHSU-SOD – faculty since 2011





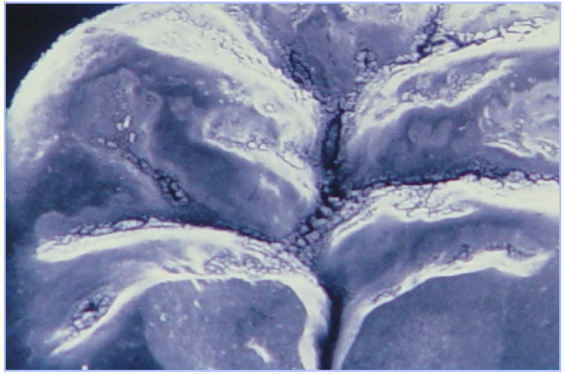
www.biomaterials-pfeiferlab.com

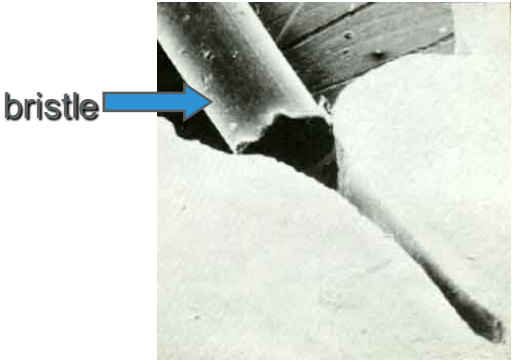
Outline

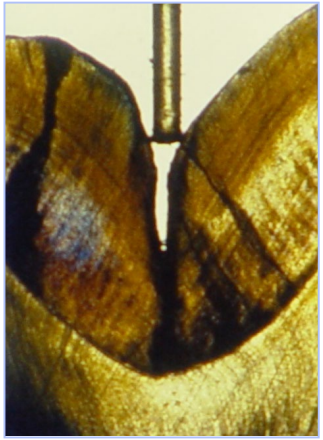
- Available materials
- Best practices for placement
- Outcomes assessment

OHSU

Anatomical considerations







- Pits and fissures vary wildly
- Partially-erupted teeth

OHSU

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**.

OHSU

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:

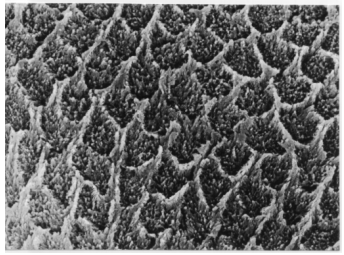
OHSU

Placement technique

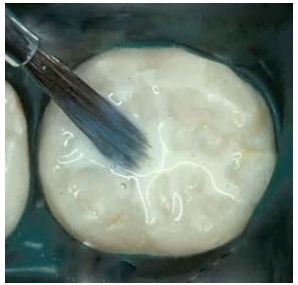
- Retention mechanism: micromechanical interlocking

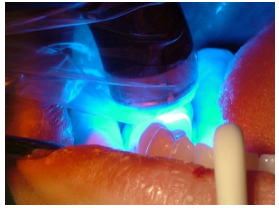
Etch/rinse
DRY

Obtain micro - mechanical interlocking – avoid contamination by saliva



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





Photocure

Bottom line: retention depends heavily on moisture control

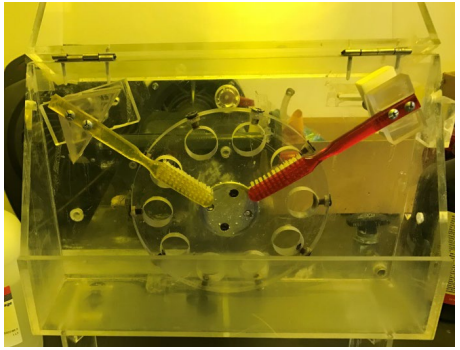
OHSU

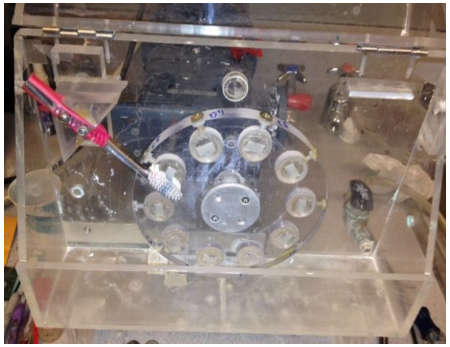
Placement technique

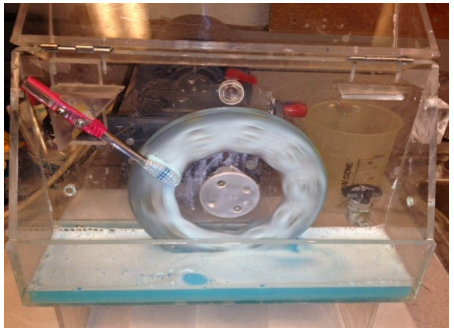
OHSU

Pediatric resident research at OHSU

- Testing the retention of resin sealants in vitro







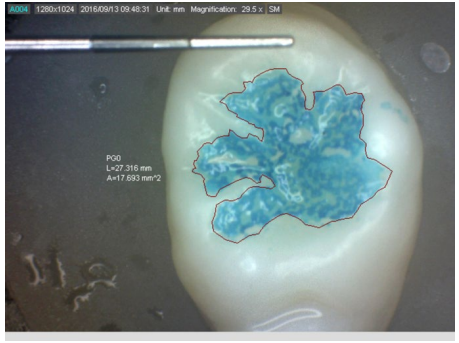
Simulated toothbrushing wear

Picture: Dr. Steven Kirby, pediatric resident

OHSU

Potential problems

- Even when there is retention, some of the sealant is also lost



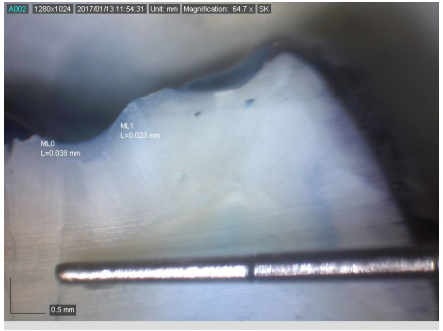
Resin sealants placed by pediatric residents following manufacturer's instructions (Ultra-seal)
Teeth cycled in toothbrushing machine – simulating 1 year of brushing
Sealants stained with methylene blue – infiltration measured under 20x

Picture: Dr. Steven Kirby, pediatric resident

OHSU

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

OHSU

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

OHSU

Glass-ionomer sealants

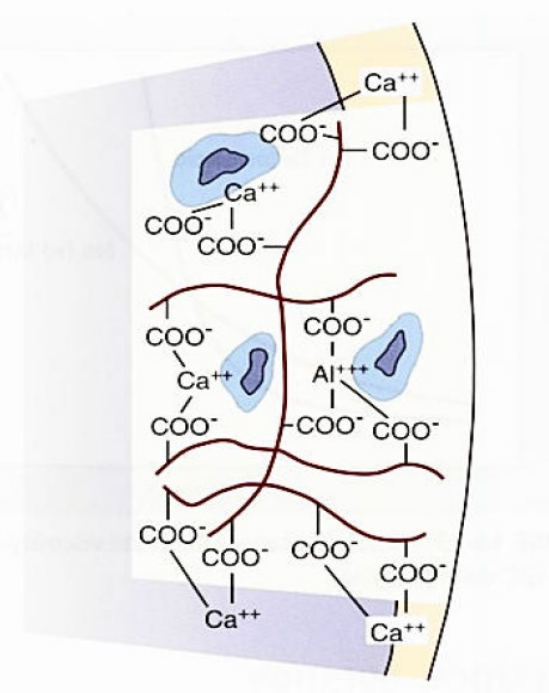
- Composition
  - Conventional: polyacrylic acid, water and aluminum/calcium fluoride powder
  - Resin-modified (RMGI): conventional + hydroxyethyl methacrylate (HEMA – photoactivated on command)

- Commercial examples

OHSU

Glass-ionomer sealants

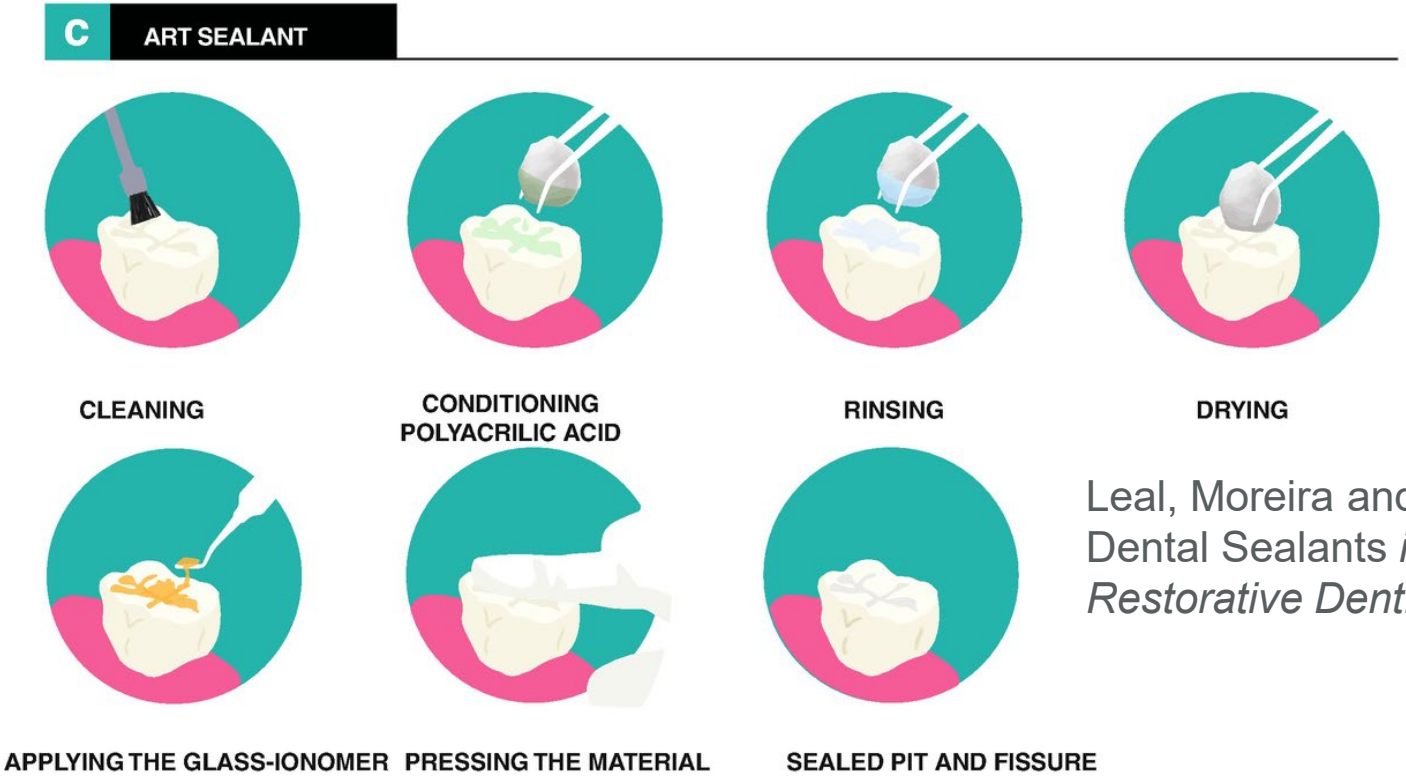
- Retention mechanism: ionic interaction with tooth surface (chelation of mineral content)
- SiO_2, Al_2O_3, AlF_3, CaF_2, NaF are dissociated in **WATER**
- Polyatomic ions serve as crosslinkers with polyacrylic acid and the mineral content in the tooth
- HEMA allows for cure on command – overcomes imbibition/synerisis concerns



Bottom line: retention is less dependent on moisture control

OHSU

Placement technique



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

OHSU

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)

OHSU

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

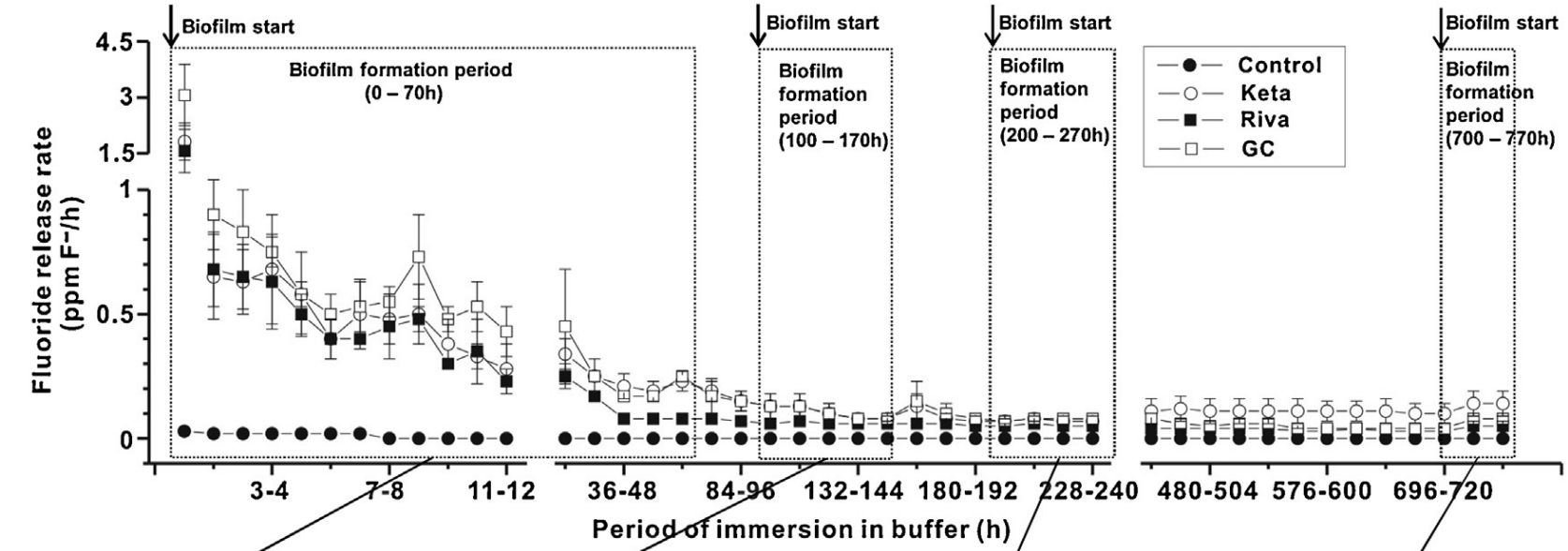
Disadvantages

- 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

OHSU

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

Chau, Journal of Dentistry 47 (2016) 34–40

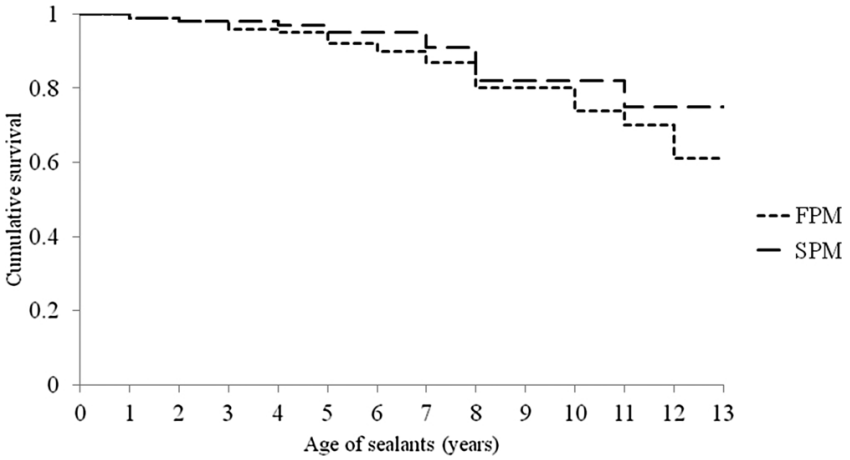
OHSU

Outcomes assessment

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

OHSU

Glass ionomer



Journal of Dentistry 79 (2018) 85–89

Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

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

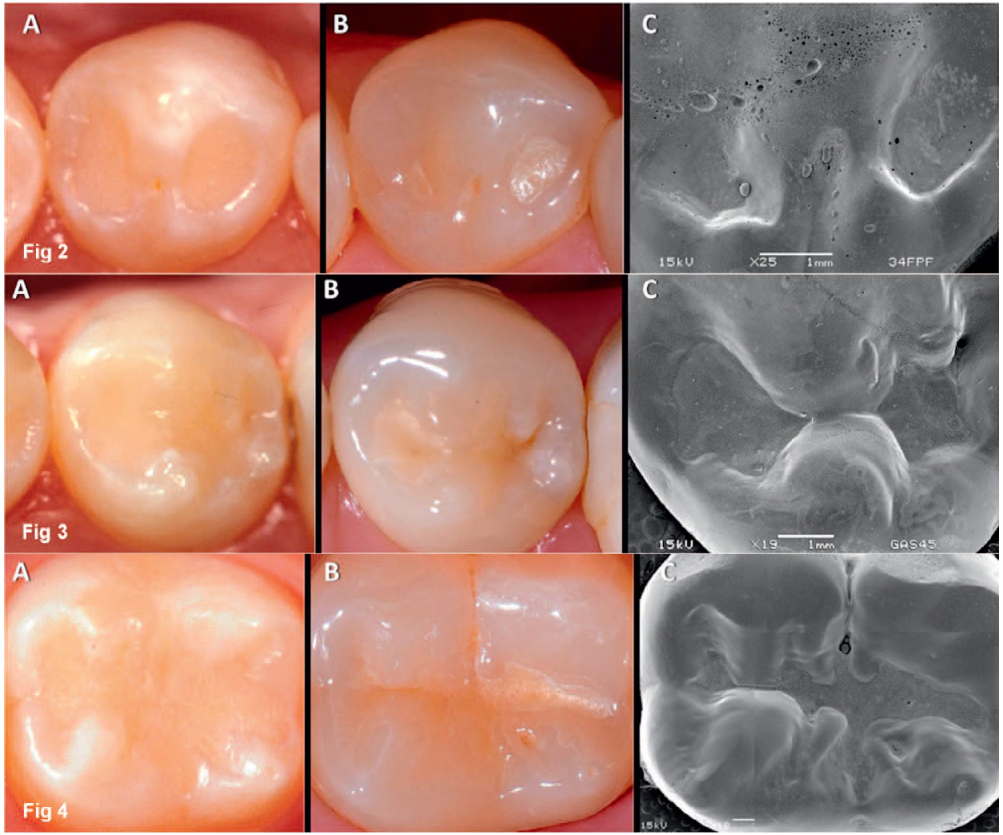
Dejan Markovic[a], Tamara Peric[a,*], Bojan Petrovic[b]

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



Sundfeld, Operative Dentistry, 2017, 42-1, 10-18

OHSU

Resin-based sealant

Cochrane Library

Cochrane Database of Systematic Reviews

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

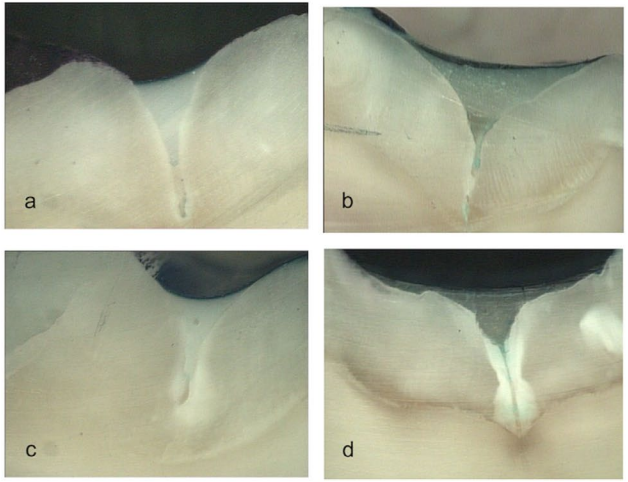
Ahovuo-Saloranta A, Forss H, Walsh T, Nordblad A, Mäkelä M, Worthington HV

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.

OHSU

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



PLOS | ONE

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[©*], Sandra María Gallego Reyes[©], Amparo Pérez Silva[©], Clara Serna Muñoz[©], Antonio José Ortiz-Ruiz[©]

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

OHSU

Comparative analyses

Journal of Dentistry 86 (2019) 69–74

Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

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[a], Zuhair Al-Nerabieah[b], Nada Bshara[b], John C. Comisi[c,*]

A: Embrace™ WetBond™

B: Fuji TRIAGE®

Table 4
Comparison of sealant retention rates.

Evaluation	Sealant retention	Group A (n=40), n = (%)	Group B(n=40), n = (%)	Significant
3 months	full retention	38 (95)	35 (87.5)	P=0.216
	Partial retention	2 (5)	2 (5)	
	full loss	0 (0)	3 (7.5)	
6 months	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

OHSU

Comparative analyses

Clinical Oral Investigations (2018) 22:3171–3177
https://doi.org/10.1007/s00784-018-2416-z

ORIGINAL ARTICLE

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

Renata Nunes Cabral[1] · Jorge Faber[1] · Simone Auxiliadora Morais Otero[1] · Leandro Augusto Hilgert[1] · Soraya Coelho Leal[1]

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

	Traditional categorisation		Modified categorisation	
Interval	FJ	CXT	FJ	CXT
	% (SE)	% (SE)	% (SE)	% (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

	Clinical evaluation	
Interval	FJ	CXT
	% (SE)	% (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.

OHSU

Comparative analyses

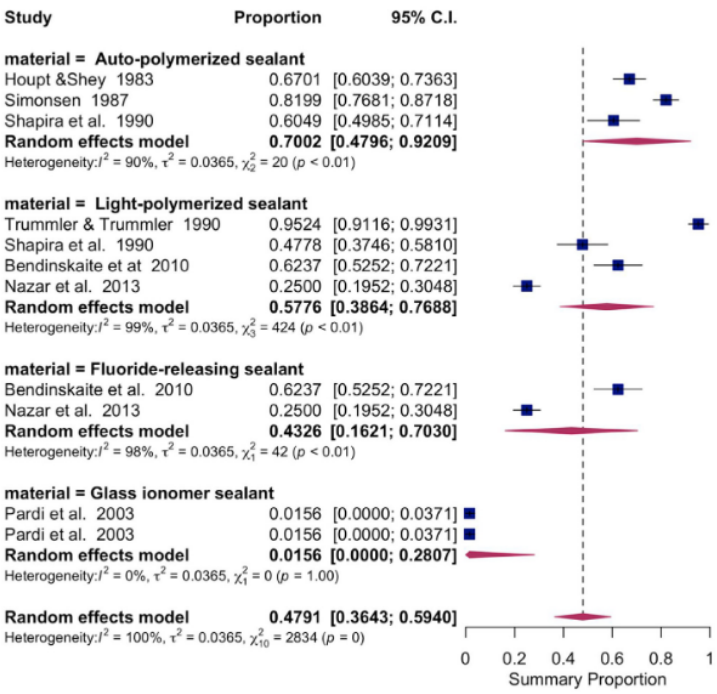


Fig. 4 – Forest plot showing a proportional meta-analysis of 4 groups of pit and fissure sealants reporting retention after a 5-year follow-up period.

DENTAL MATERIALS 36 (2020) e158–e168

Available online at www.sciencedirect.com

ScienceDirect

ELSEVIER

journal homepage: www.intl.elsevierhealth.com/journals/dema

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

Jan Kühnisch[a,], Ahmed Bedir[a,b], Yi-Fang Lo[a], Andreas Kessler[a], Toni Lang[a], Ulrich Mansmann[b], Roswitha Heinrich-Weltzien[c], Reinhard Hickel[a]*

Conclusion

Retention of GIC sealants is poorer than resin-based sealants

OHSU

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

OHSU

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

OHSU

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

Thank You

pfeiferc@ohsu.edu

Comparative retention – in vivo

Material	Mean	SD	Median	Kruskal-Wallis Chi-square	*P* value
At 6 months					
Delton	0.15	0.53	0.00	93.295	<0.001*
Clinpro	0.34	0.83	0.00		
Embrace	0.16	0.60	0.00		
Fuji VII	1.14	1.13	1.00		
At 12 months					
Delton	0.34	0.86	0.00	80.788	<0.001*
Clinpro	0.64	1.20	0.00		
Embrace	0.38	0.94	0.00		
Fuji VII	1.75	1.34	1.00		

*Denotes significant difference

Delton – applied with adhesive
Clinpro – applied without adhesive
Embrace – moisture-tolerant resin-based
Fuji VII – conventional GIC

Bhat, Contemp Clin Dent. 2013 Jul-Sep; 4(3): 343–348.