Dental sealants

Material-related clinical outcomes

DATE: August 5, 2022 PRESENTED BY: Carmem Pfeifer, DDS, PhD, Professor, Division Director

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

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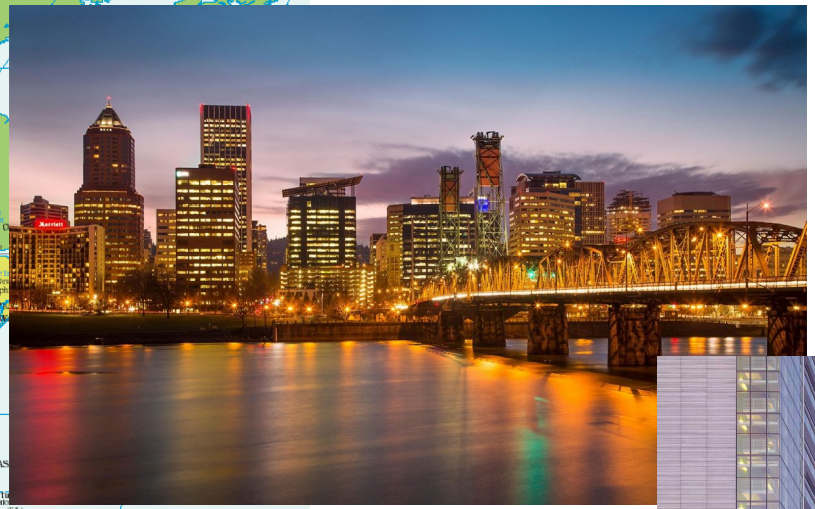
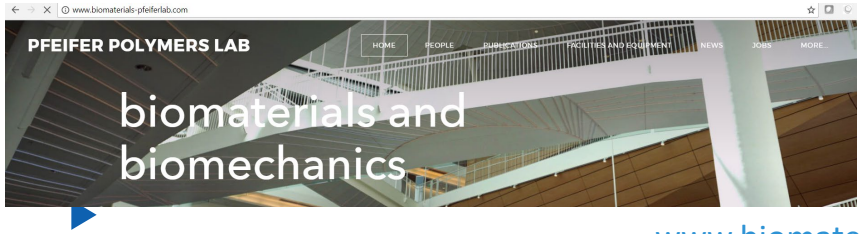
OHSU-SOD – faculty since 2011





www.biomaterials-pfeiferlab.com

Outline

- Available materials
- Best practices for placement
- Outcomes assessment

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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**.

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MYTHBUSTERS

MythBusters

- Sealants should only be placed on sound enamel

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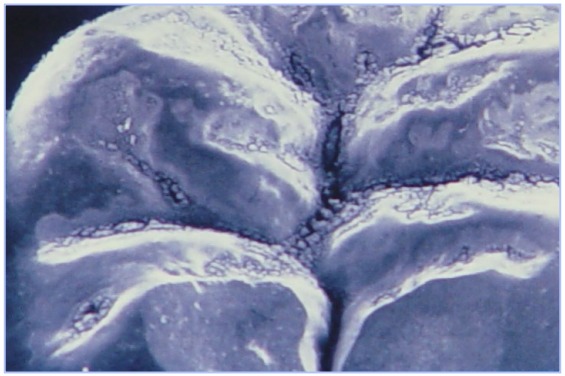
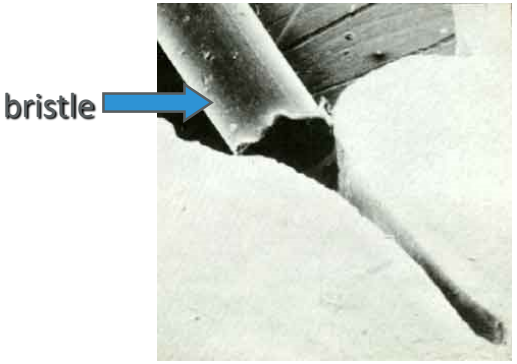
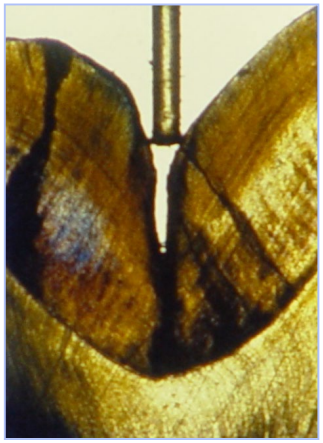
Anatomical considerations







- Pits and fissures vary wildly
- Partially-erupted teeth

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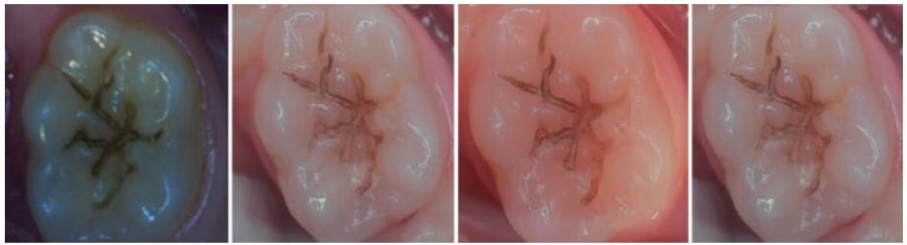
Sealing non-cavitated lesions

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[b])	14 (3.9[b])	41 (12.0[b])	47 (13.6[b])
Control	58 (14.8[a])	68 (17.6[a])	90 (23.7[a])	110 (31.2[a])

[a] Groups with letters a and b show significant difference (P≤ 0.05).



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

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

- 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

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MythBusters

- Sealants sh[BUSTED!]ced on sound

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MythBusters

- Only replace sealants if they are not visible without magnification

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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:

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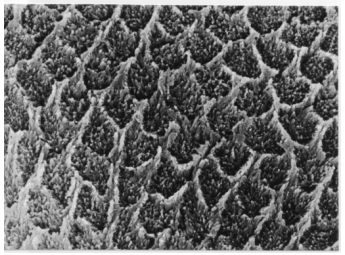
Placement technique

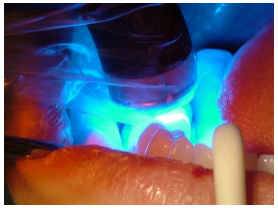
- Retention mechanism: micromechanical interlocking

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

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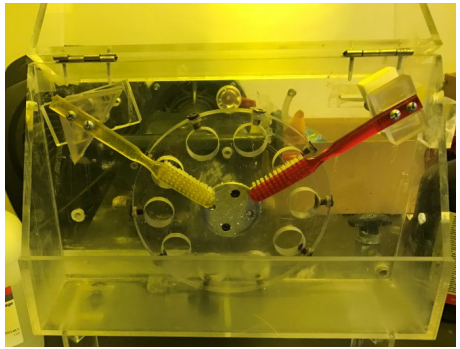
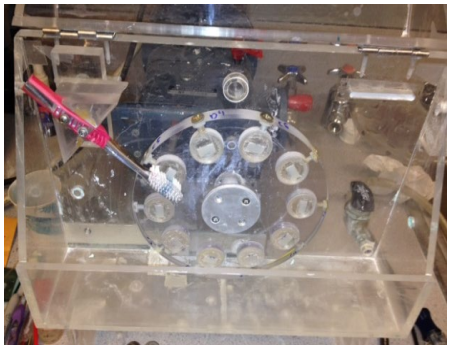
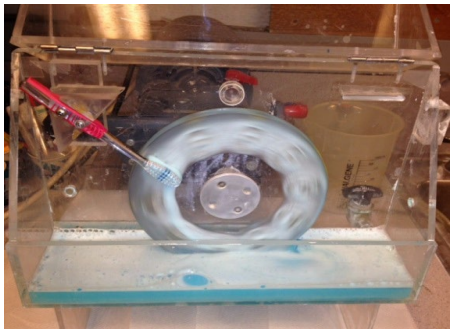
Placement technique

Pediatric resident research at OHSU

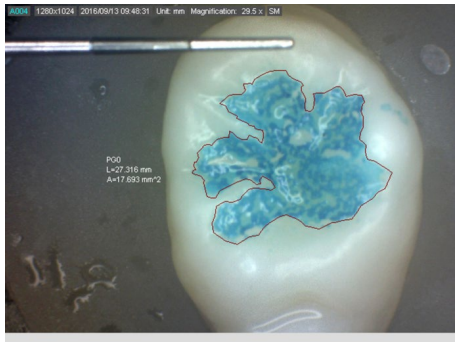
- Testing the retention of resin sealants in vitro







Simulated toothbrushing wear



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

Picture: Dr. Steven Kirby, pediatric resident

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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

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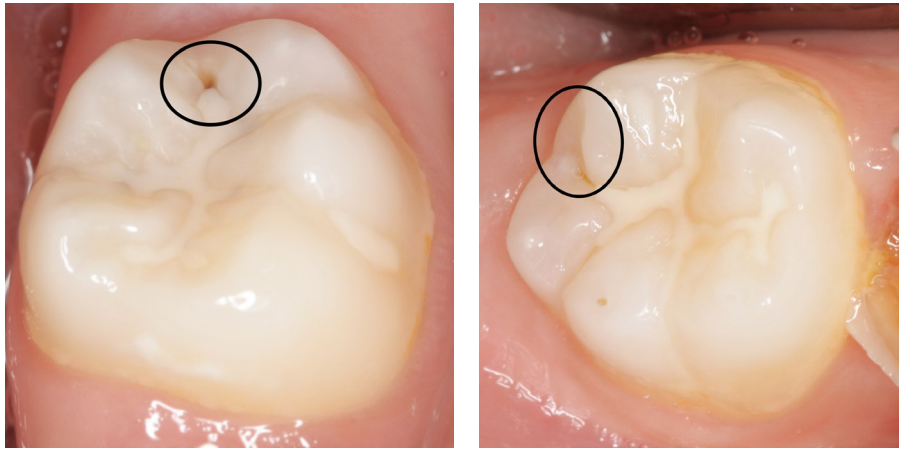
Replacing sealants: when and why?



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

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

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

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MythBusters

- Only repla[illegible]y are not visibl[illegible]gnification

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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

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MythBusters

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

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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

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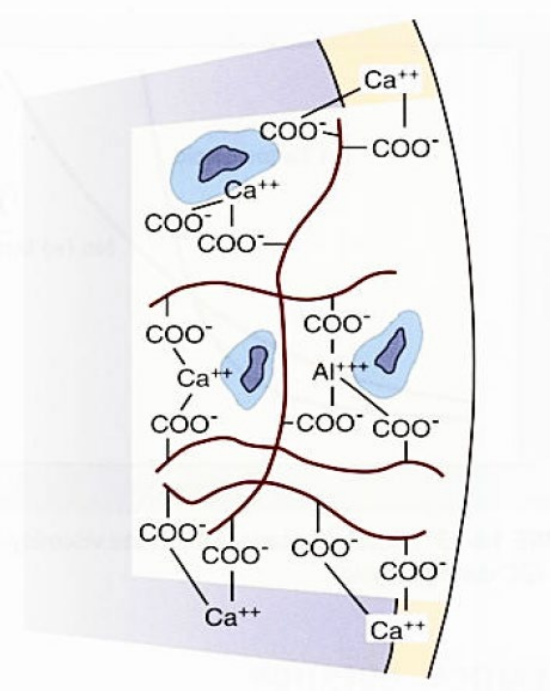
Glass-ionomer sealants

- 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

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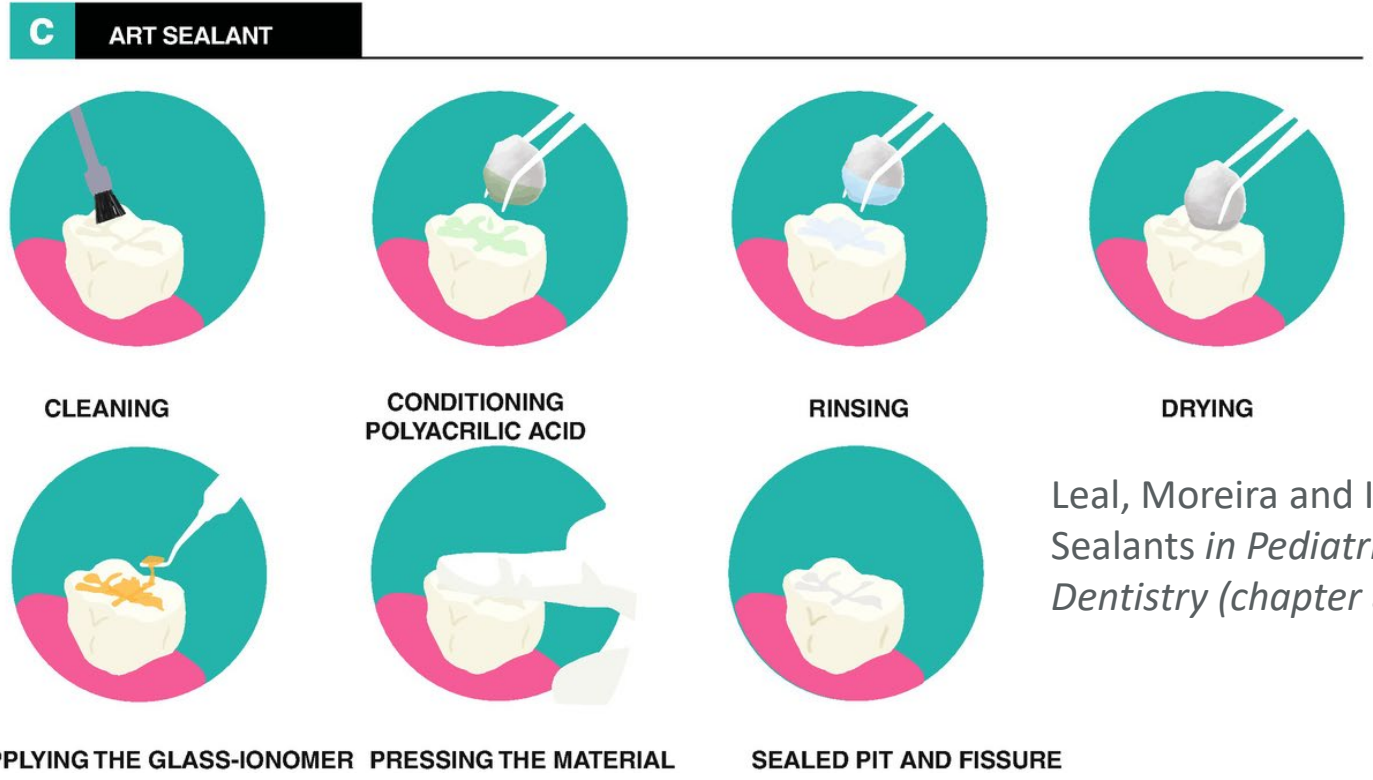
Placement technique



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

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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)

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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

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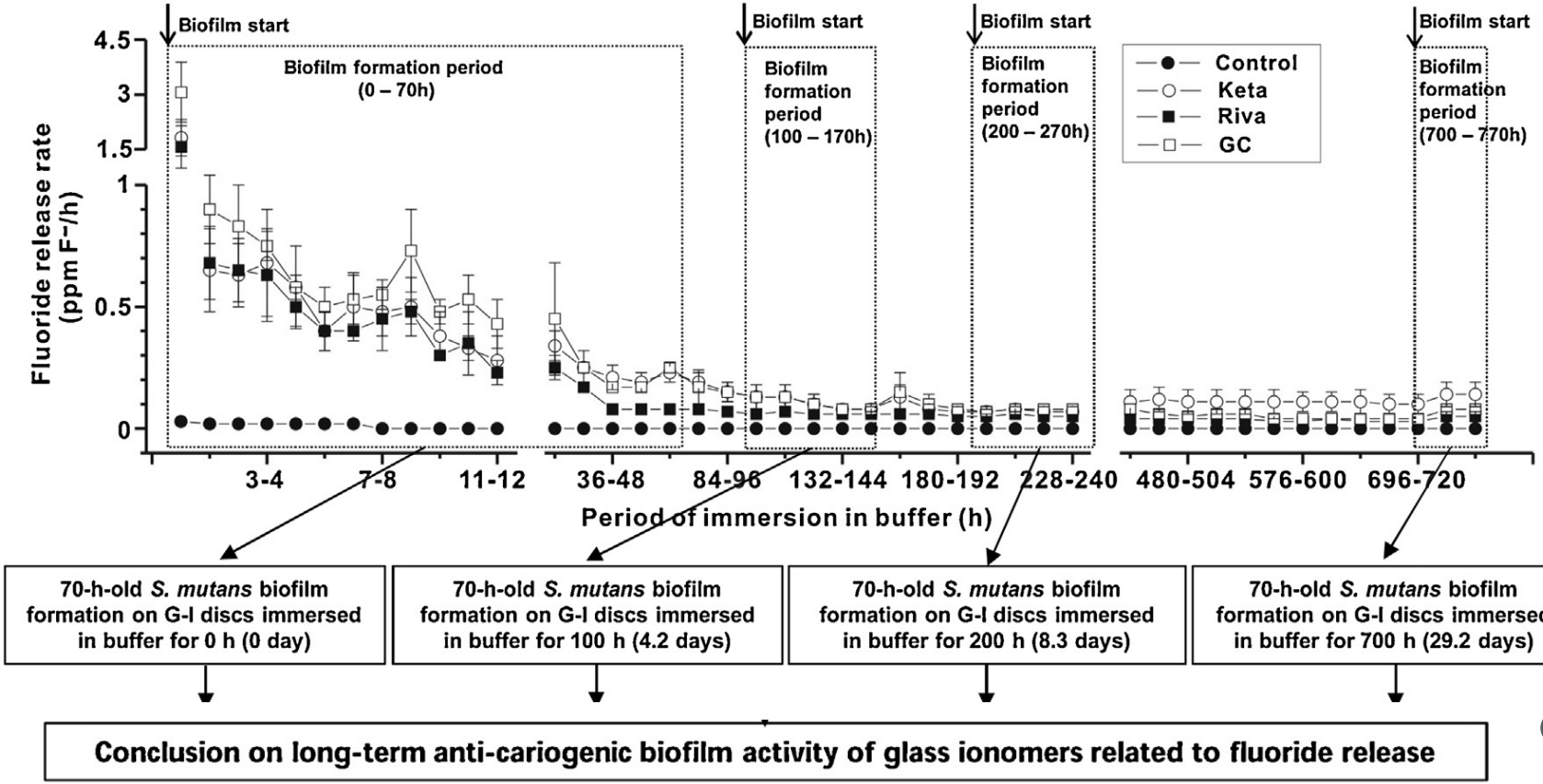
Fluoride release – in vitro



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

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MythBusters

- Fluoride re[illegible]ants is only s[illegible]e sealant is visible [illegible]e surface without magnification

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MYTHBUSTERS

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

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Outcomes assessment

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

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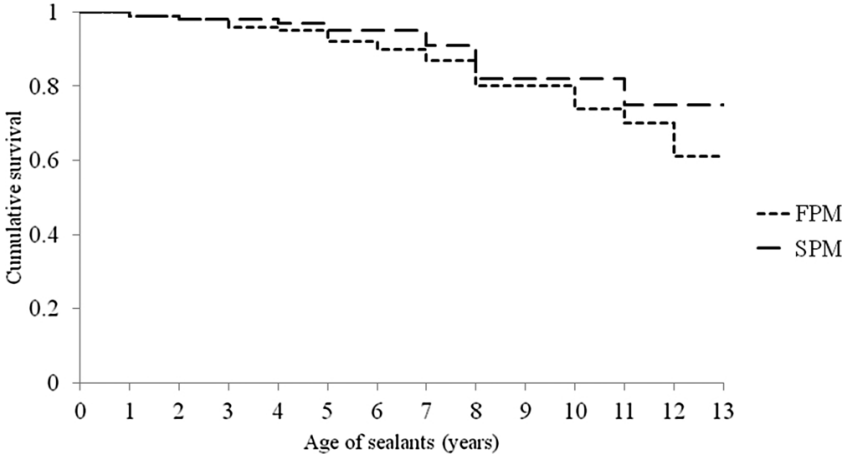
Glass ionomer



Journal of Dentistry 79 (2018) 85–89

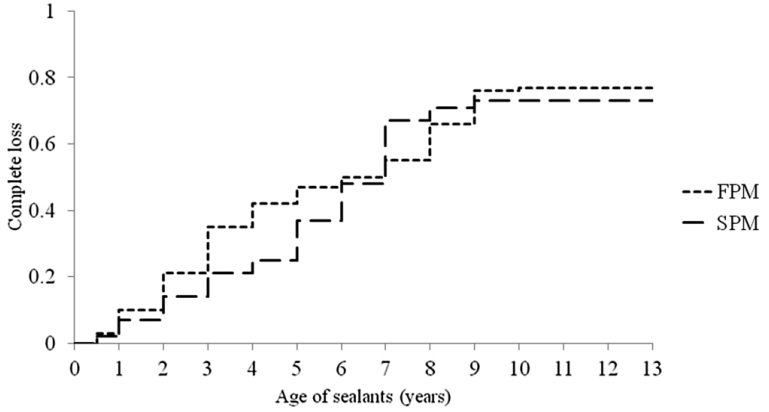
Contents lists available at ScienceDirect

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.

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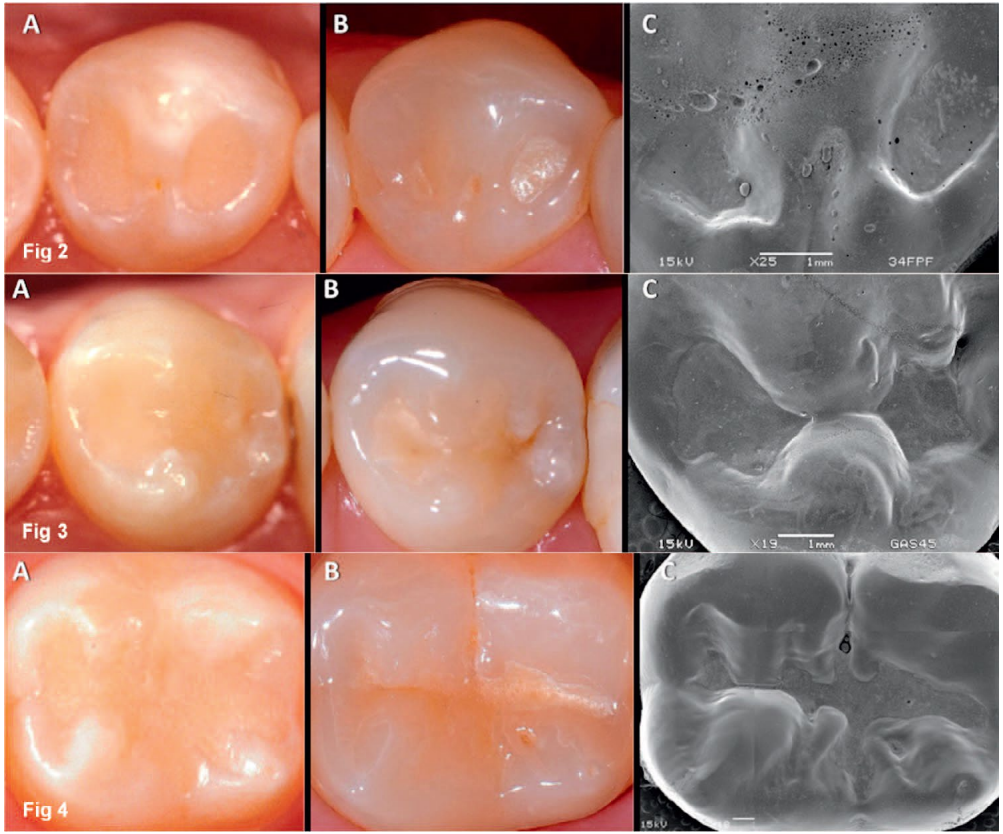
RMGIC retention – 22 year clinical follow up

- 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

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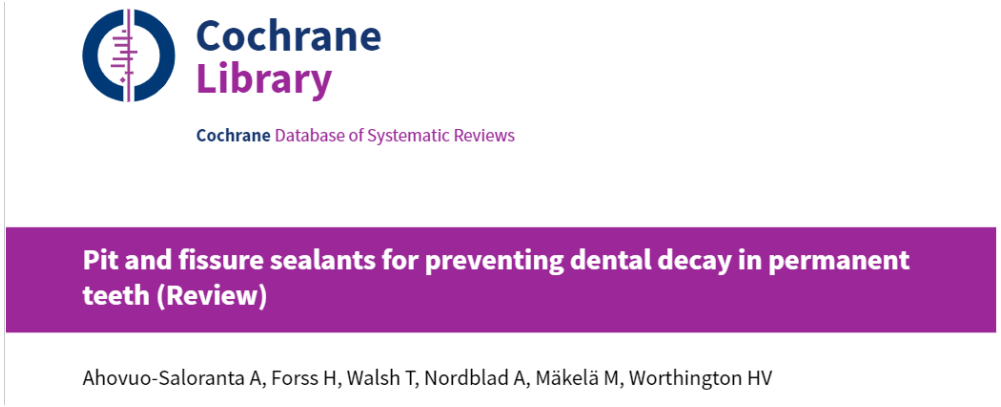
Resin-based sealant



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.

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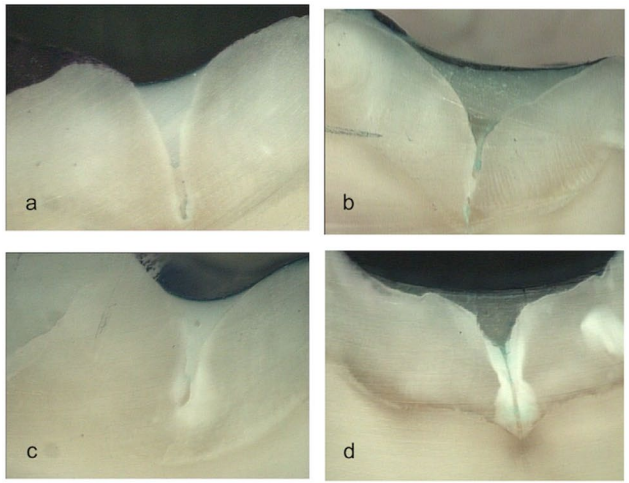
Comparative analyses

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

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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

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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.

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Comparative analyses

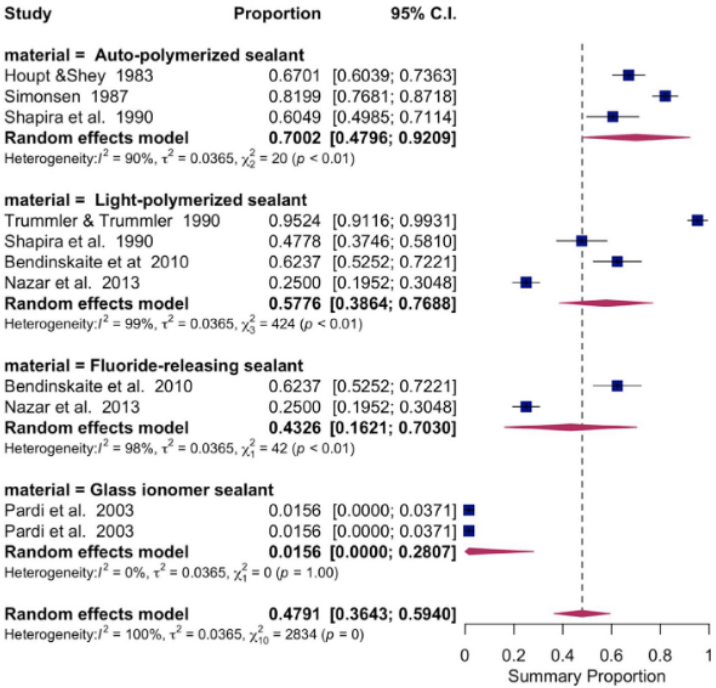

Fig. 4 – Forest plot showing a proportional meta-analysis of 4 groups of pit and fissure sealants reporting retention after a 5-year follow-up period.

DENTAL MATERIALS 36 (2020) e158–e168

Available online at www.sciencedirect.com

ScienceDirect

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

MythBusters

- GI is an inf… interi… …er than a more perma… resin sealant

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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

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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

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

Thank You

pfeiferc@ohsu.edu