



Anticariogenic capacity of restorative materials in paediatric dentistry: *in vitro* evidence vs. clinical efficiency

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Current treatment objectives

- Restoration with minimal intervention and caries prevention
- Longevity without secondary caries
- Evidence-based selection of materials and techniques

Is there any clinical evidence?

- There is very little real clinical research
- Marketing and sales thrive on laboratory results as evidence for product support.
- There is a need for understanding the complex intra-oral environment and the interactions of materials, interfaces and tissues over-time

(Bayne, 2006)

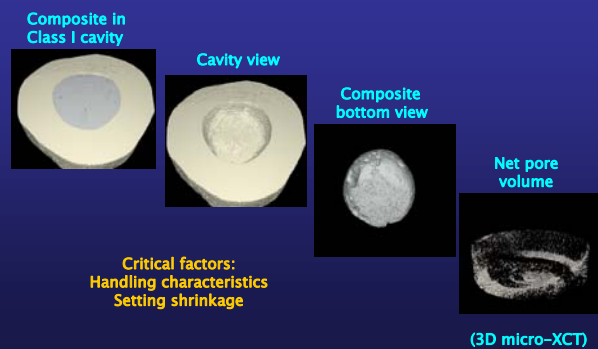
Problems in interpreting the evidence

- How accurately do clinicians interpret research evidence ?
- How can research data be linked to clinical practice?
- How accurate and valid are research data?

Consensus for replacement of restorations: criteria

- Quality of marginal adaptation /secondary caries
- Mechanical properties
- Color alteration

Marginal adaptation: setting shrinkage

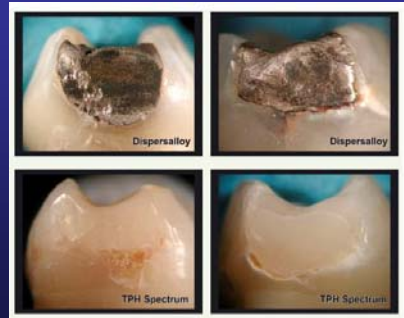


Marginal adaptation: marginal deterioration



Secondary caries primary caries at defective restoration margins

(Ozer and Thylstrup A, 1995)



(Manakou et al 2005)

Materials with anticariogenic capacity

- F
- Ca or OH (buffering effect)
- Sr, Al, Zn
- Antimicrobial agents (adhesives)

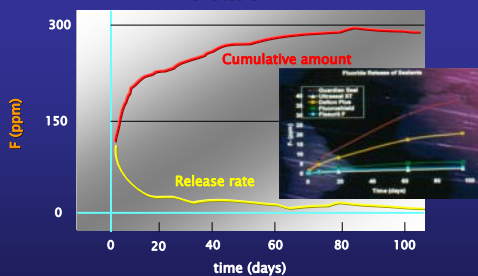
Assessment of F release from materials

- Amount of F released
- Amount of F uptake by tooth tissues and plaque
- Resistance to caries development
- Expression of antimicrobial effect

TYPE OF STUDIES

In vitro
In situ
In vivo
Clinical /retrieval

F release



- Cumulative graphs have no meaning (assume close systems)
- All the materials demonstrate an initial short-term high release period (elution) followed by a long-term low-release period (diffusion)



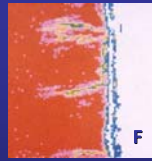
- The actual F amount required to obtain a cariostatic effect is unknown
- Increased F release should not be considered among the primary material selection criteria
- High F release rate indicates material dissolution

Assessment of F uptake

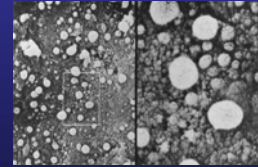
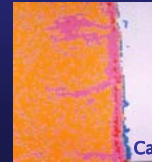
- Adjacent cavity walls of hard dental tissues
- Dental plaque
- Adjacent teeth (interproximal contacts)
- Restorative materials (F recharging)

F uptake from gels, liquids and varnishes

SEM-WDS ELEMENTAL MAPPING



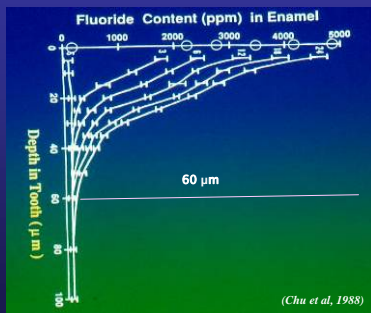
Superficial CaF_2 rich layer (precipitation induced)



(Cruz et al, 1992)

(Are really CaF_2 particles available on enamel surface or are dehydration precipitates induced by HV-SEM imaging?)

Depth of F penetration



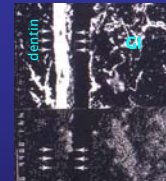
F uptake from dental materials

Artifacts



No counter ion or core material element as reference

Same distribution of Al and F for an AlF_3 system (fracture, not uptake)

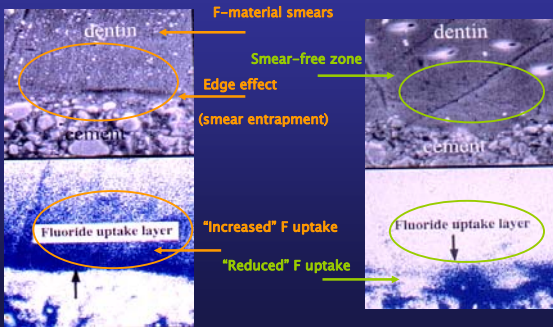


Same distribution of Al and F for an AlF_3 system (fracture, not uptake)

Interfacial debonding in HV SEM/X-ray microanalysis: cohesive material fracture is frequently considered as an uptake phase. A common error in analysis of water-based cements. (Duschner et al, 1995)

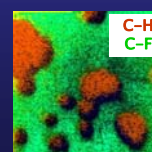
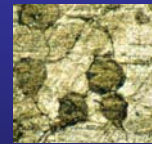
Surface contamination

F uptake by hard tissues



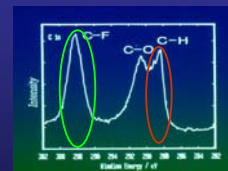
State of F uptake

crystalline, amorphous, adsorbed



XPS mapping

XPS C1s Curve Fitting



Adsorbed organic-F coating (not F uptake)

Assessment of F uptake

- Adjacent cavity walls of hard dental tissues
- Dental plaque
- Adjacent teeth (interproximal contacts)
- Restorative materials (F recharging)

F recharging of restorative materials

To maintain the cariostatic activity since the F release reaches a low release plateau over time

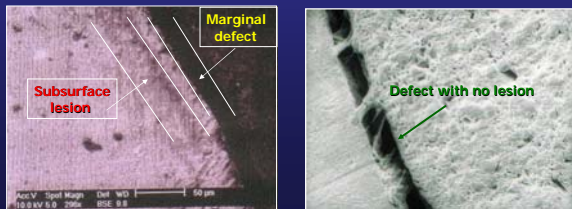
- Glass-ionomers are better recharged due to the presence of
 - Loosely bound water
 - Structural porosity and solutes that enhance passive diffusion recharge processes

APF gels are contraindicated as they may produce erosive damage

Intraorally, saliva and plaque strongly reduce F release from recharged surfaces

Problems in the clinical evaluation of the anticariogenic properties of restorative materials

Extremely difficult to differentiate the effect of adhesive marginal sealing from the therapeutic effect attributed to the release of species with anticariogenic capacity.

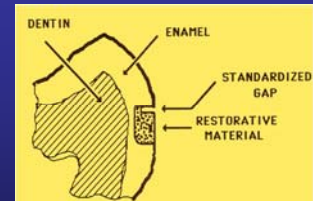


In vitro

Role of interfacial gaps in caries development



Ketac-Fil/without gap



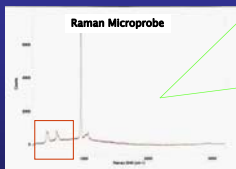
Ketac-Fil/ with gap

Smaller lesions in the presence of interfacial gaps!! (increased area of F release)

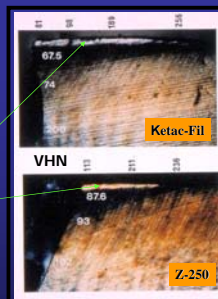
(Papagiannoulis et al 2002)

In vivo

Role of interfacial gaps in caries development



No lattice mode vibrations for CaF_2



FREQUENCY AND SIZE OF THE DEVELOPED LESIONS

RESTORATIVE (n=8, 6 m)	FREQUENCY (%)	LENGTH (μm)	DEPTH (μm)
KETAC-FIL	75.0%	754±43	277±22
Z-250	62.5%	384±36	214±22

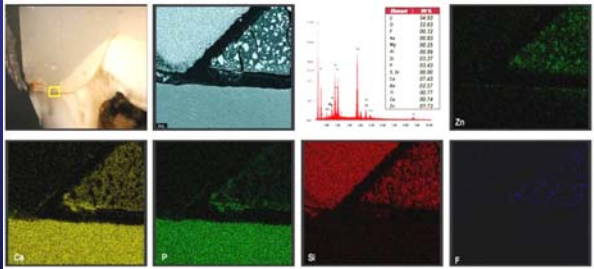
Retrieval analysis Optical microscopy



Debonding of F releasing liners and bases

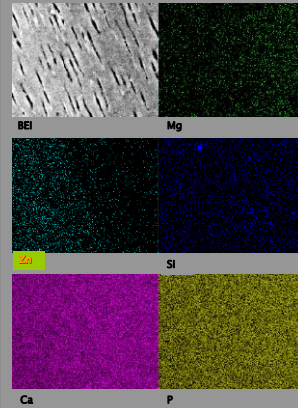


RETRIEVAL ANALYSIS SEM/X-ray EDS microanalysis



No F uptake from F-releasing GI

ANTICARIES EFFECT OF AMALGAM?



In depth Zn diffusion

CLINICAL STUDIES no evidence in favor of F releasing materials

Mjor IA. *Quintessence Int* 1996;27:171-174.

Wilson NHF, Burke FJT, Mjor IA. *Quintessence Int* 1997;28:245-248.

Randall R, Wilson NHF. *J Dent Res* 1999;78:628-637.

Wiegand A, Buchalla W, Attin T. *Dent Mater* 2007;23:343-362.

Conclusions

- There is conflicting clinical evidence on whether the F releasing materials prevent or inhibit secondary caries compared to non-F restoratives
- More and well-designed clinical studies are required to evaluate the capacity of these materials in caries development and progression
- Until clear and critical information is available from clinical studies, no material should be designed focusing more on the F releasing capacity rather than adhesion, marginal durability mechanical strength

