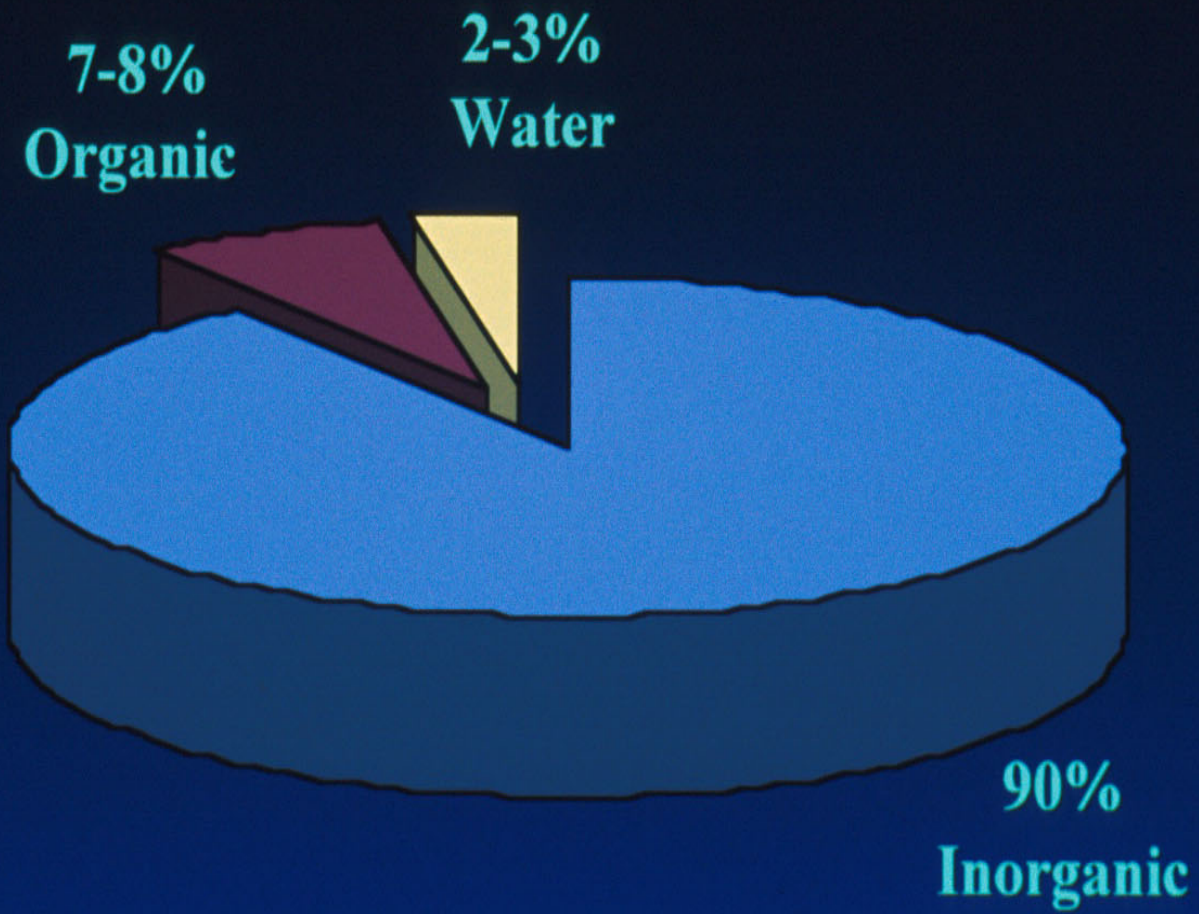
Bonding to dentine: How it works

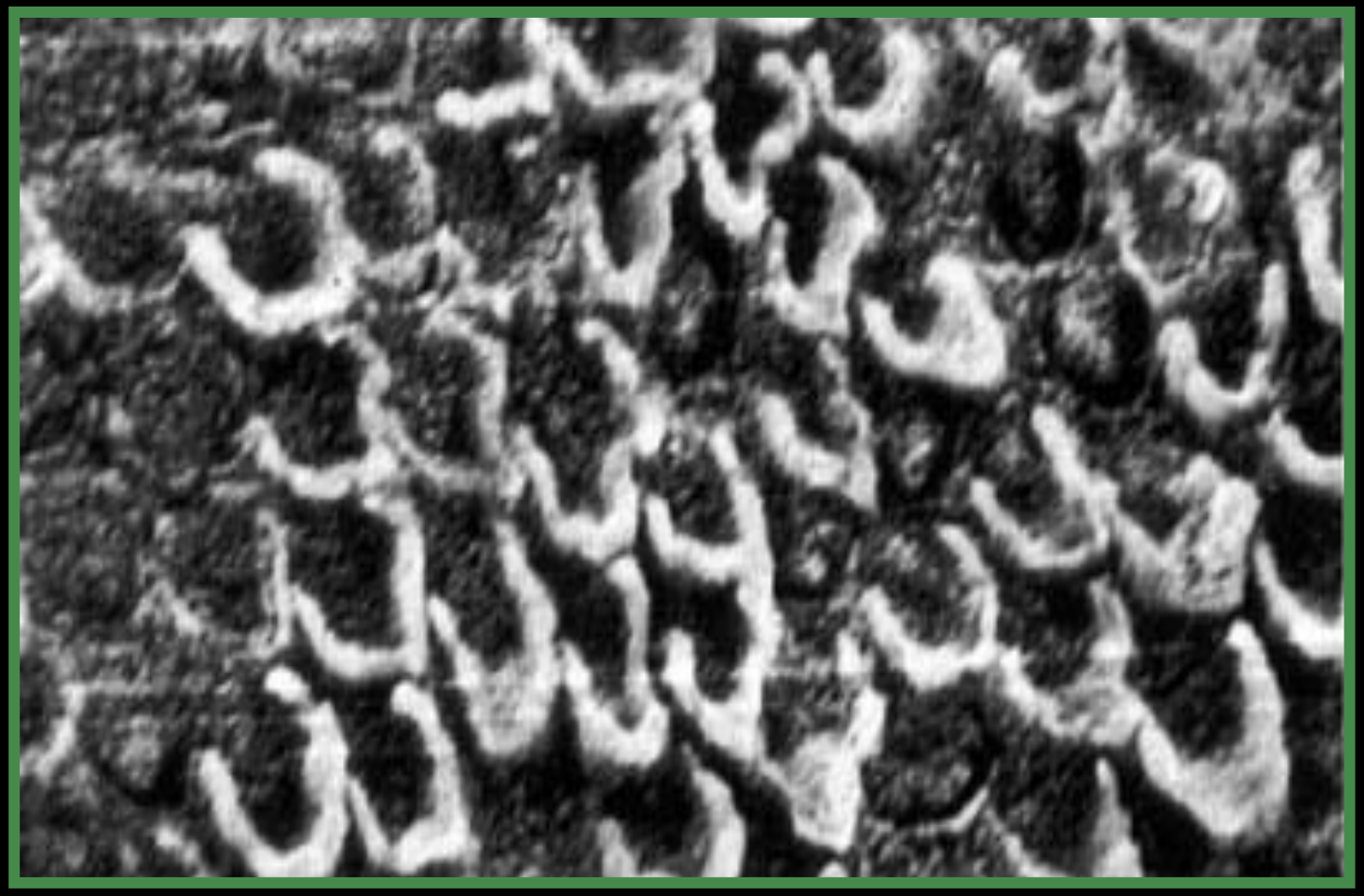
The future of restorative dentistry

There are 82 adhesive systems on the market today!

Are dentists confused about bonding?

Enamel : Constituents by Volume





Michael Buonocore

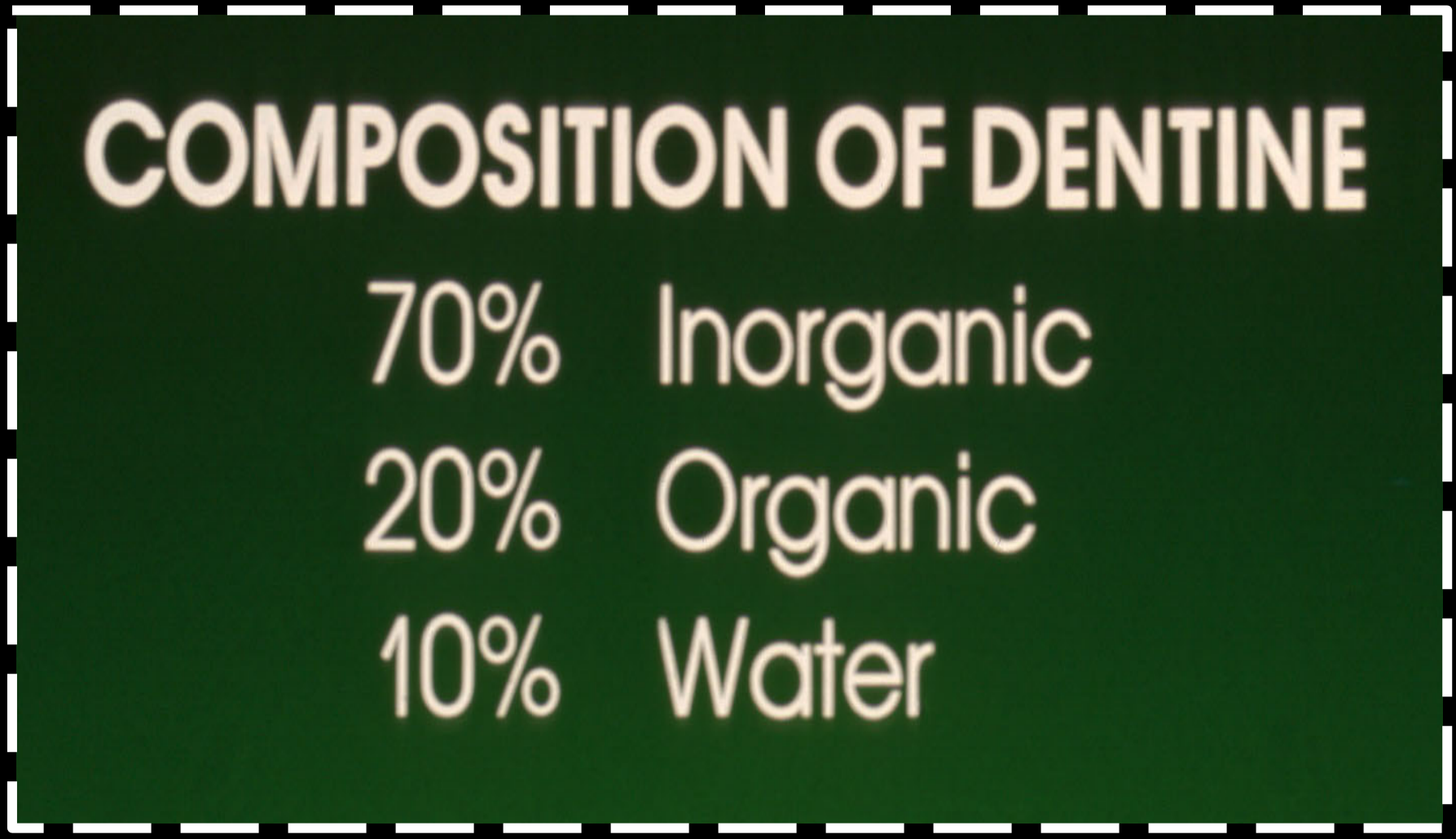
Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J.Dent.Res.1955:34(6):849-853.

Composites can be pretty!

and, bonding to enamel is easy

History Of Bonding

Year	Discovery	Main Points
1955	**Acid Etching**	Buonocore advocates etching to achieve better bonding to tooth structure
1963	**Recognition Of Different Substrates**	Buonocore discusses differences in bonding to enamel and dentin
Late 1960´s	**Resin Tags**	Buonocore discusses resin tags as the principal adherents to etched enamel
1990´s	**Shorter Etching Time**	15 Seconds is about enough for dentin



Bonding to dentine is therefore more difficult

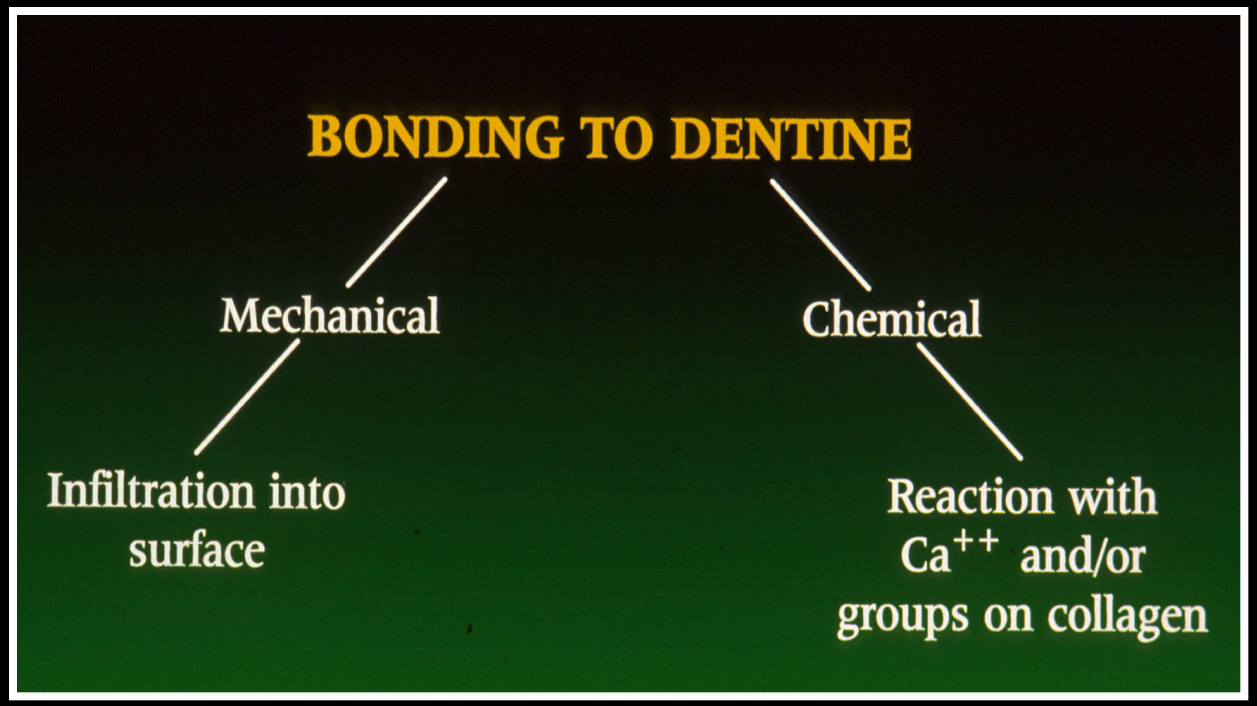
Why do dentists need adhesion?

- Cervical restorations
- Build up of fractured anterior and posterior teeth
- Short clinical crown for full or partial coverage restorations
- Resin retained bridges

Bonding to dentine

Chemical = Glass ionomer

Micromechanical = Dentine bonding systems



‘There is no evidence of any chemical reaction of any dentine bonding system to hydroxyapatite, except for polycarboxylate’

D.C.Smith, 1989

Glass Ionomer Cement

- A cement that consists of a basic glass and an acidic polymer which sets by an acid-base reaction between these components

McLean et al., 1994

The Glass Ionomer Family

- Traditional glass ionomers
- Glass ionomer luting materials
- Cermets
- Resin-modified glass ionomer (RMGI)
- Reinforced glass ionomers :ART materials
- RMGI luting materials

Characteristics of Glass Ionomers

- Release of fluoride
- Adhesion to enamel and dentine
- Biocompatibility
- Low thermal diffusivity
- Initial reaction to moisture
- Marginal integrity

Characteristics of Glass Ionomers

- Finishing and polishing
- ? To etch: The sandwich technique
- Aesthetics
- Mechanical strength
- Erosion and abrasion resistance

Uses of glass ionomer materials

- Class III and Class V restorations
- Liners/bases
- Core build-up/foundation restorations
- Luting materials
- Restoration of deciduous teeth
- Tunnel restorations
- Repair of defective margins
- Temporary/provisional restorations

Resin Modified Glass Ionomers

Hybrid materials that retain a significant acid/base reaction as part of their overall curing process.

McLean et al., 1994

Reinforced Glass ionomer materials

- Smaller particle size leads to faster reaction
- Higher loading brings improved physical properties
- Exhibits plastic features – can be condensed and packed
- Still a need for improved wear resistance
- Typical glass ionomer features

Take home message

Traditional glass ionomers have poor physical properties and should be confined to history.

Reinforced and RMGI materials are superior.

Maximising class V effectiveness

The survival of Class V restorations in general dental practice: part 3, five-year survival

D. Stewardson,[1] S. Creanor,[2] P. Thornley,[3] T. Bigg,[4] C. Bromage,[5] A. Browne,[6] D. Cottam,[7] D. Dalby,[8] J. Gilmour,[9] J. Horton,[10] E. Roberts,[11] L. Westoby[12] and T. Burke[13]

RESEARCH

IN BRIEF

- This study reminds dentists that they are the most important factor determining the survival of Class V restorations.
- Presents evidence that has been collected from a large number of restorations placed in dental practices and is therefore likely to be particularly relevant to general practitioners.
- Identifies a number of factors associated with poor restoration survival which can help dentists improve their patient care.

Objective To evaluate the survival over five years of Class V restorations placed by UK general practitioners, and to identify factors associated with increased longevity. **Design** Prospective longitudinal cohort multi-centre study. **Setting** UK general dental practices. **Materials and method** Ten general dental practitioners each placed 100 Class V restorations of varying sizes, using a range of materials and recorded selected clinical information at placement and recall visits. After five years the data were analysed using the Kaplan-Meier method, log-rank tests and Cox regressions models to identify significant associations between the time to restoration failure and different clinical factors. **Results** After five years 275/989 restorations had failed (27.8%), with 116 (11.7%) lost to follow-up. Cox regression analysis identified that, in combination, the practitioner, patient age, cavity size, moisture contamination and cavity preparation were found to influence the survival of the restorations. **Conclusions** At least 60.5% of the restorations survived for five years. The time to failure of Class V restorations placed by this group of dentists was reduced in association with the individual practitioner, smaller cavities, glass ionomer restorations, cavities which had not been prepared with a bur, moisture contamination, increasing patient age, cavities confined to dentine and non-carious cavities.

Maximising class V effectiveness: what is associated with failure at 5 years?

Restorations involving dentine only: hazard of failure increased by 39%

Large restorations compared with small: hazard of failure increased by 85%

Major or minor moisture contamination: hazard of failure increased by 29%

Preparation method/rotary instrument used: hazard of failure decreased by 40%

Maximising class V effectiveness: what material is best at 5 years?

Five year survival

RMGI 78.6%

Amalgam 75%

Compomer 71.2%

Flowable composite 69%

Composite 68.3%

Glass ionomer 50.6%

OBJECTIVE

To reliably seal the dentinal tubules

If the tubules are sealed using a Dentine Bonding System……

The ideal dentine bonding system should:

- Provide an immediate, permanent, high-strength bond to dentine
- Bond to dentine = bond to enamel
- Minimizes microleakage
- Show no reduction in bond strength when applied to a moist surface
- Be biocompatible with dental tissues

The ideal dentine bonding system should:

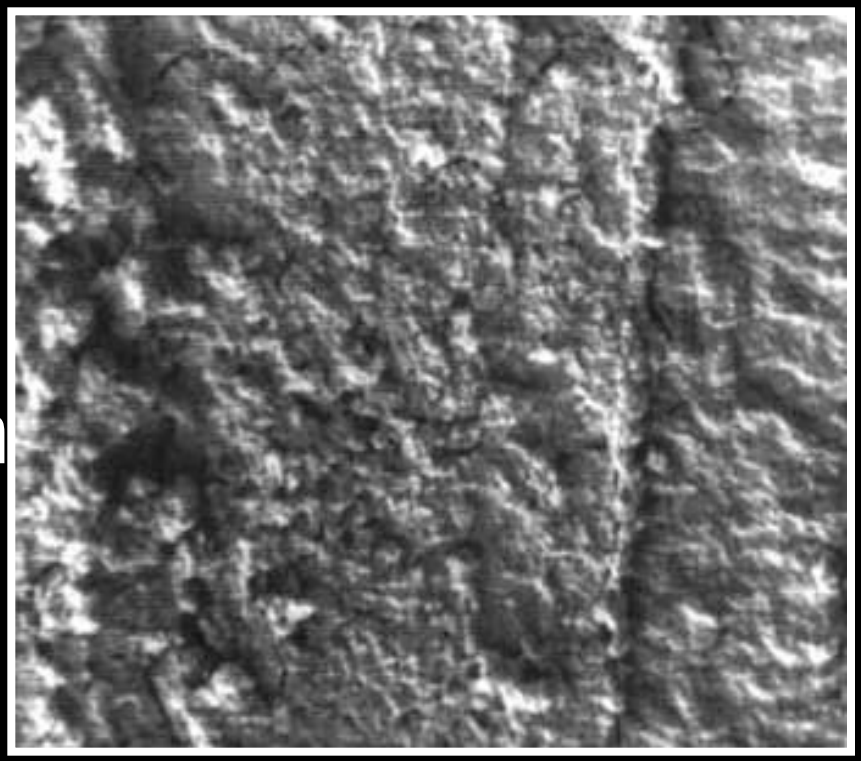
- Be easy to use and not technique sensitive
- Have a good shelf life
- Be compatible with a wide range of resins
- Not sensitise operators or patients
- Seal the cavity and thereby help to prevent recurrent caries

Problems with bonding to dentine

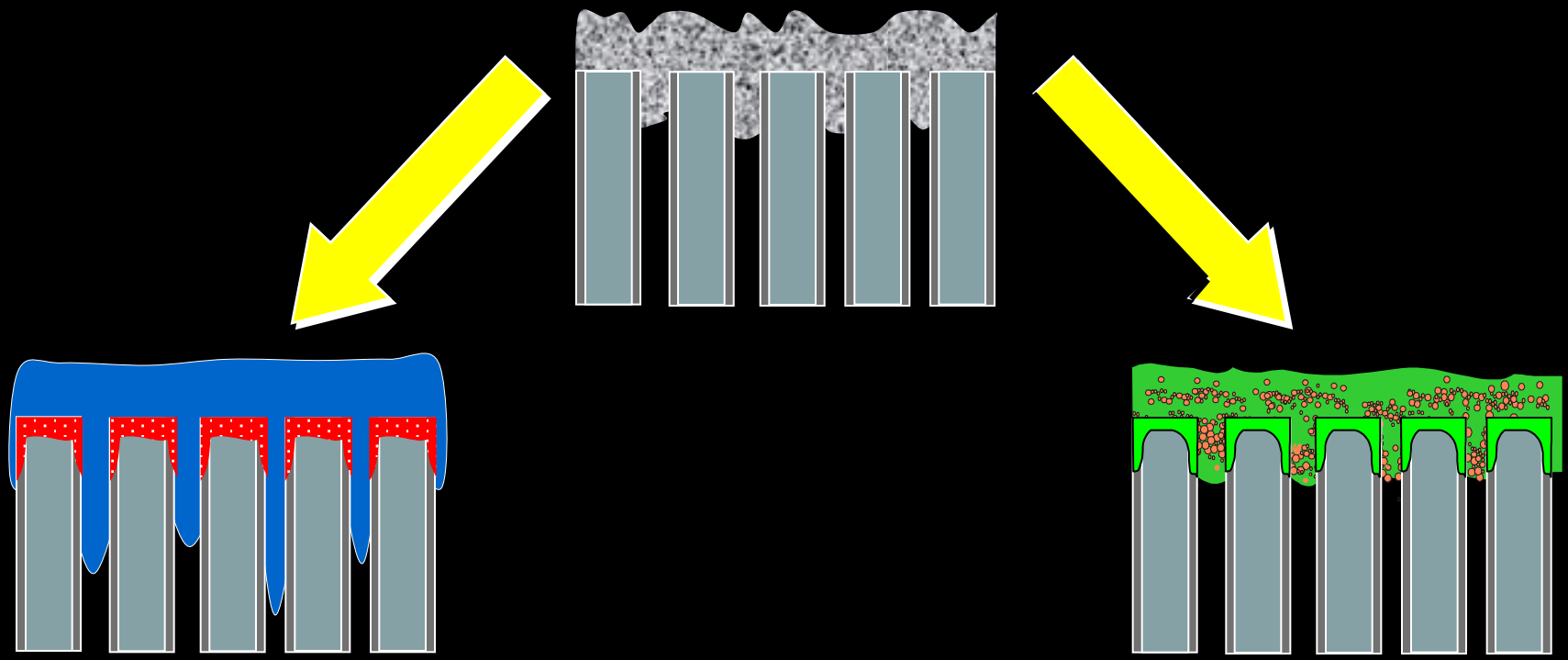
- Dentine is 22% water by volume
- Polymerisation contraction of resin-based materials
- Smear layer present on dentine surface
- Early polishing of composite
- Different substrates
- Technique sensitivity of (early) dentine bonding agents

Smear Layer

- Thickness
  - 0.5 - 5.0 microns
- Will not wash off
- Weak bond to tooth
  - 2 – 3 MPa
- Very soluble in weak acid



Previous strategies to treat the smear layer



Etch & Rinse/

Etch & Bond
(Total etch)

Self etch/

No Rinse

The quality of the hybridised dentine is more important than the bond strength

Nakabayashi, 2002

The classification *until recently* of dentine bonding systems

1. Etch and rinse (etch & bond, total etch)

2. Self etch → **One bottle**

→ **Two bottles**

...NOW!

….introducing

a new group of dentine bonding agents

Universal bonding agents

Treatment of the smear layer

- REMOVE (Etch & Rinse/Total etch)
- LEAVE/PENETRATE (Self etch)
- UNIVERSAL MATERIALS (Etch & Rinse, Selective enamel etch, Self etch) (use for direct and indirect)

Scotchbond Universal Adhesive

- Works with both Total- and Self-Etch technique, therefore high flexibility in clinical procedures
- Provides procedural simplicity
- Total-etch or Selective-enamel etch for highest enamel bond strength, e.g. incisal edges
- Self-etch for low post-op sensitivity
- Fast technique where isolation is difficult, or with non-co-operating patients

Scotchbond Universal Adhesive: Composition

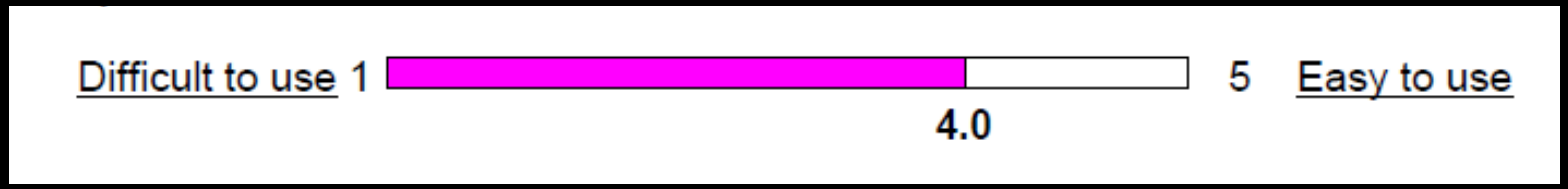
- BisGMA
- MDP
- Vitrebond Copolymer
- HEMA
- Ethanol
- Water
- Filler
- Silane
- Initiators

Handling evaluation of 3M ESPE Scotchbond Universal by the PREP Panel

- 12 evaluators
- Variety of bonding agents used pre-study
- 875 restorations placed (Class 1:172, Class II:189, Class III:134, Class IV:178, Class V:182, Other:20) Also used for dentinal hypersensitivity, repair of fractured porcelain, bonding of posts.
- Rated material on visual analogue scales
- 75% of evaluators would be prepared to pay extra for the convenience of single-unit doses
- All stated that the resin liquid easily wet the tooth surface, that the bond was easily visible. Some commented that it was “too yellow”

Handling evaluation of 3M ESPE Scotchbond Universal by the PREP Panel

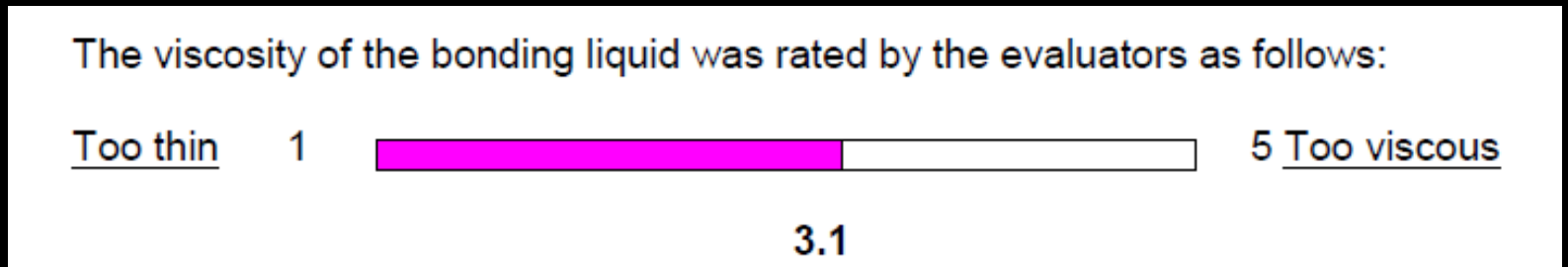
Ease of use of previous bonding agent



Ease of use of Scotchbond Universal

Viscosity of Scotchbond Universal

The viscosity of the bonding liquid was rated by the evaluators as follows:



Handling evaluation of Scotchbond Universal by the PREP Panel: Comments

- 📖 "Disconcertingly yellow – but OK when thinned or light cured"
- 📖 "Spreads well when air applied"
- 📖 "Supposedly the lid can be opened one-handed but it is sometimes a problem"
- 📖 "First material that compares with G-Bond"

Handling evaluation of Scotchbond Universal by the PREP Panel: Comments

- All the evaluators stated that they would purchase if available at average price.
- "Extremely useful to have a material that bonds both to indirect restorations as well as the tooth structure. No need for multiple kits of materials. So far has worked well."

Universal bonding agents

new additions are on the way!

Clearfil Universal:what's in it?

10-MDP
Bis-GMA
2-HEMA
Hydrophilic aliphatic dimethacrylate
Colloidal silica
Silane coupling agent
Di-Camphorquinone
Ethanol
Water

GC G-Premio Bond:What's in it?

4-META
10-MDP
10-Methacroyldecyl dihydrogen thiophospate
Methacrylate ester
Acetone
Distilled water
Photoinitiators
Silica fine powder

SUMMARY: Universal bonding agents:

Can be used in total etch, self etch, selective enamel etch modes

Are compatible with direct & indirect procedures

Can be used with self & dual cure luting materials (with separate activator)

Are suitable primers for silica & zirconia

Can bond to different substrates

…other tips for optimal bonding..

Effects of moisture degree and rubbing action on the immediate resin-dentin bond strength
Dal-Bianco K, Pellizzaro A, et al.
Dent.Mater.2006

Conclusion:

High bond strength to dentine can be obtained under dry conditions when ethanol/H_2O and acetone based systems are vigorously rubbed on the dentine surface. On wet surfaces, light rubbing may suffice.

Rules for bonding

Do not overdry the surface

Etch according to manufacturers' instructions

Try to avoid etching the dentine.

Do not overblow resin layer

Rub in the adhesive

Advantages of an adhesive approach

- Tooth and patient friendly
- Potentially better aesthetics
- Can be metal-free
- State of the art (practice building)
- There is increasing evidence that it works

  BUT……

- Care, time, attention to detail and operator ability paramount

Take home messages

Dentine bonding is now reliable and effective

Self etch adhesives do not produce bond strengths as high as etch & rinse systems

Selective etching of enamel is a good idea

Universal bonding materials with MDP are now the business

The future…

is…….
bonding restorations
to teeth