### Results:

- **Hard Bridge Formation**

The increased inflammation with the Glass Ionomers and VLC Dycal may have retarded hard tissue bridge formation.

<table>
<thead>
<tr>
<th>Hard Tissue Bridge</th>
<th>TheraCal</th>
<th>Portland</th>
<th>Glass Ionomer</th>
<th>VLC Dycal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>11</td>
<td>12</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
Results:

- Hard Bridge Formation

Phase Contrast Microscope
Results:

- Hard Tissue Bridge Thickness
  - TheraCal and Portland average the same thickness
  - Glass Ionomer and VLC Dycal average less than a fifth as thick as TheraCal

<table>
<thead>
<tr>
<th>Material</th>
<th>TheraCal</th>
<th>GIC</th>
<th>PC</th>
<th>Dycal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>50.27μ</td>
<td>10.72μ</td>
<td>60.72μ</td>
<td>10.90μ</td>
</tr>
</tbody>
</table>
Measured thickness of the hard tissue bridges with the pure Portland and TheraCal groups statistically greater than that of the other two groups (H=15.849 with 3 degrees of freedom, P=0.002).
Results:

- MicroCT
- Light cured

Primate Pulpal Healing after Exposure and TheraCal Application

Cannon M*/ Gerodias N**/ Vieira A***/ Percinoto C****/ Jurado R*****

Aim: The purpose of this in vivo study was to compare the effectiveness of a new light cured resin based
dicalcium/tricalcium silicate pulp capping material (TheraCal LC, Biscol), pure Portland cement, resin based
calcium hydroxide or glass ionomer in the healing of bacterially contaminated primate pulps. Study design:
The experiment required four primates each having 12 teeth prepared with buccal penetrations into the pulp
tissues with an exposure of approximately 1.0 mm. The exposed pulps of the primate teeth were covered with
cotton pellets soaked in a bacterial mixture consisting of microorganisms normally found in human pulpal
abscesses. After removal of the pellet, hemostasis was obtained and the pulp capping agents applied. The light
cured resin based pulp capping material (TheraCal LC) was applied to the pulpal tissue of twelve teeth with a
needle tip syringe and light cured for 15 seconds. Pure Portland cement mixed with a 2% Chlorhexidine
solution was placed on the exposed pulpal tissues of another twelve teeth. Twelve additional teeth had a
base of GIC applied (Triage, Fuji VII GC America) and another twelve had a pulp cap with VLC DYCAL
(Dentsply), a light cured calcium hydroxide resin based material. The pulp capping bases were then covered
with a RMGI (Fuji II LC GC America). The tissue samples were collected at 4 weeks. The samples were
deminerallized, sectioned, stained and histologically graded. Results: There were no statistically significant
differences between the groups in regard to pulp inflammation (H= 0.679, P=1.00). However, both the
Portland cement and light cured TheraCal LC groups had significantly more frequent hard tissue bridge
formation at 28 days than the GIC and VLC Dycal groups (H= 11.950, P=0.009). The measured thickness of
the hard tissue bridges with the pure Portland and light cured TheraCal LC groups were statistically greater
than that of the other two groups (H= 15.849, P=0.002). In addition, the occurrence of pulpal necrosis was
greater with the GIC group than the others. Four premolars, one each treated according to the protocols were
analyzed with a microCT machine. The premolar treated with the light cured TheraCal LC demonstrated a
complete hard tissue bridge. The premolar treated with the GIC did not show a complete hard tissue bridge
while the premolar treated with VLC Dycal had an incomplete bridge. The pure Portland with Chlorhexidine
mixture created extensive hard tissue bridging.

Conclusion: TheraCal LC applied to primate pulps created dentin bridges and mild inflammation acceptable
for pulp capping.

Key words: pulp exposures, pulp response, bacteria, primate
Bioactivity and Dental Materials

- History of severe dental apprehension
- Mother wants only natural products
Bioactivity and Dental Materials

Pulpally involved, pulp extirpated from chamber. Ferric sulfate placed for hemostasis.
Treatment with sodium hypochlorite for disinfection, clot debridement and removal of pulpal tags. Step most often skipped.

Vital versus non-vital

Warm Bodies
Great parody of life-death
Bioactivity and Dental Materials

Remove excess sodium hypochlorite. If concentrated but water may contaminate chamber. PROBLEMATIC.
Hemostasis obtained, all pulp contents removed, essential for pulpal therapy success
Bioactivity and Dental Pulpal dressing - TheraCal DC Dual cured TheraCal - extremely biologically kind.
Bioactivity and Dental Materials

Light cure to initiate polymerization but will dual cure completely due to proprietary technology.
Etch enamel for 30 seconds with Uni Etch BAC. Rinse with copious water flow.
Bioactivity and Dental Materials

Cured adhesive and TheraCal DC obturation of chamber
Inject dual cure Activa restorative into cavity preparation.
Bioactivity and Dental Materials

Explorer tine to evenly spread Activa without void incorporation "Pulse" cure
Bioactivity and Dental Materials

Matrix and wedge removed
Note gross anatomy
Bioactivity and Dental Materials

Post operative visit
EndoCal Products

Indications:
- Endodontic sealer
- Furcation repair
- Internal resorption
- External resorption
- Apicoectomy
Family

Keith, Christopher, and Ryan.
Most dental materials are designed to be “passive” and to have a relatively “neutral” existence in the mouth so that they will be biocompatible and cause neither harm nor injury.*

This passive approach neglects the possibility that positive gains can be achieved with “active” materials that behave in a dynamic fashion in the oral environment.*

* McCabe JF, et al. Smart materials in dentistry. School of Dental Sciences, Newcastle University, UK.
Bioactive materials are considered to have “smart” behavior if:

1. They have the capacity to interact with living tissue or systems;* and
2. They can react to changes in the environment to bring about advantageous changes in properties, either within the material itself or in the material-tooth complex.**

The development of bioactive materials is inspired by nature.

** McCabe JF, et al. Smart materials in dentistry. School of Dental Sciences, Newcastle University, UK.
Can you say Micro-Leakage?
Sometimes... however...

The simpler does not deliver the best!
Simplified-step adhesives lack coupling resin layer – more permeable

They contain higher concentration of acidic and hydrophilic monomers

More vulnerable to water sorption and leaching

Potential long-term consequence
Current evidence confirms that Etch&Rinse adhesives are not capable of fully infiltrating demineralized dentin. (Wang & Spencer)

What is the fate of the exposed unprotected collagen fibers?
Exposed Collagen by Acid Etching
And activation of MMPs

Four-year water degradation of total-etch adhesives bonded to dentin.

Leuven BIOMAT Research Cluster, Department of Conservative Dentistry, School of Dentistry, Oral Pathology and Maxillo-Facial Surgery, Catholic University of Leuven, Kapucijnenvoer 7, B-3000 Leuven, Belgium.

Abstract
Resin-dentin bonds degrade over time. The objective of this study was to evaluate the influence of variables like hybridization effectiveness and diffusion/elution of interface components on degradation. Hypotheses tested were: (1) There is no difference in degradation over time between two- and three-step total-etch adhesives; and (2) a composite-enamel bond protects the adjacent composite-dentin bond against degradation. The micro-tensile bond strength (microTBS) to dentin of 2 three-step total-etch adhesives was compared with that of 2 two-step total-etch adhesives after 4 years of storage in water. Quantitative and qualitative failure analyses were conducted correlating Fe-SEM and TEM. Indirect exposure to water did not significantly reduce the microTBS of any adhesive, while direct exposure resulted in a significantly reduced microTBS of both two-step adhesives. It is concluded that resin bonded to enamel protected the resin-dentin bond against degradation, while direct exposure to water for 4 years affected bonds produced by two-step total-etch adhesives.

H-layer disappeared completely in 4 yrs (De Munck et al., 2003)
Durability of bonds to dentin

Multi-step vs. reduced steps

Enamel vs. dentin

Hydrophobic vs. hydrophilic
Clinical effectiveness of contemporary adhesives: A systematic review of current clinical trials

M. Peumans*, P. Kanumilli, J. De Munck, K. Van Landuyt, P. Lambrechts, B. Van Meerbeek

Three-step total-etch adhesives showed the most reliable clinical performance

Simplified versions were outperformed by the multi-step versions of adhesives
“Deterioration of water-immersed polyethylene coated wire by treeing”

Miyashita (1969)
Chlorhexidine Arrests Subclinical Degradation of Dentin Hybrid Layers *in vivo*

J. Hebling¹, D.H. Pashley², L. Tjäderhane³, and F.R. Tay²,⁴*

*J Dent Res 84(8):741-746, 2005*

6 months...

ccontrol

CXH 2%
- Place cotton pellets tightly in preparation.
- Etch enamel for 30 seconds.
- Remove cotton pellets and then smear etchant into preparation onto dentin for 5 seconds.
- OR - then use your 6th or 7th generation adhesive.

Rolando Nunez technique: Hybrid Etching

Apply 5th Generation to etched dentin (3-5 secs) OR use 6th or 7th generation to un-etched dentin.
Critical Dry Point

Dentin easily etched

Collagen fibrils exposed
Easily infiltrated by water chasing primers
Dentin

- Air dried dentin
- Collage collapses into amorphous surface
- Not easily penetrated by water chasing primers
Uni-Etch with Benzylkonium Chloride

Wet Bonding
Hybrid Layer Preservation
What is the?

MMPs = Matrix Metalloproteinases

Collagen eating enzymes-
“collagenase” MMPs 1 and 8

- activated by acid on dentin
Synthetic MMPs inhibitors

- Synthetic inhibitors generally contain a chelating group which binds the catalytic zinc atom at the MMP active site tightly.
- Doxycycline, at sub antimicrobial doses, inhibits MMP activity, and has been used in various experimental systems for this purpose; such as for recalcitrant recurrent corneal erosions. It is used clinically for the treatment of periodontal disease and is the only MMP inhibitor which is widely available clinically. It is sold under the trade name Periostat by the company CollaGenex.
- Minocycline, another tetracycline antibiotic, has also been shown to inhibit MMP activity. Both have been utilized to prevent inflammatory resorption of replanted traumatically avulsed teeth.

Animal studies
MMPs inhibition by Chlorhexidine

- Chlorhexidine has been reported to inhibit MMPs and, as a result of this finding, been added to dentin bonding procedures apart from being a commonly known disinfectant. Chlorhexidine also functions as a potent MMP inhibitor (Gendron et al., 1999).
Benzalkonium chloride, also known as alkyltrimethylbenzylammonium chloride and ADBAC, is a mixture of alkylbenzyldimethylammonium chlorides of various even-numbered alkyl chain lengths. This product is a nitrogenous cationic surface-acting agent belonging to the quaternary ammonium group.

The mechanism of bactericidal/microbicidal action is thought to be due to disruption of intermolecular interactions. This can cause dissociation of cellular membrane lipid bilayers, which compromises cellular permeability controls and induces leakage of cellular contents. Other biomolecular complexes within the bacterial cell can also undergo dissociation. Enzymes, which finely control a wide range of respiratory and metabolic cellular activities, are particularly susceptible to deactivation.
CHX - MMP Inhibitor

Suggested to use CHX *in-vivo*. (JDR 2004; 83;216)

w/CHX in 12 m

w/o CHX in 12 m

Chlorhexidine is an effective MMP inhibitor

**Bond Strengths (14 m in-vivo)**

**CHX preserves Hybrid layer & bond strength!**

<table>
<thead>
<tr>
<th></th>
<th>24 h (MPa)</th>
<th>14m (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control</strong></td>
<td>29.3 (9.2)</td>
<td>19.0 (5.2)</td>
</tr>
<tr>
<td><strong>With CHX</strong></td>
<td>32.7 (7.6)</td>
<td>32.2 (7.2)</td>
</tr>
</tbody>
</table>

Carrilho et al., JDR 2007; 86; 529
Bisco Etchant with BAC

- Residual antimicrobial effect

BAC is MMP Inhibitor / Dr. Pashley

Zone of inhibition

Bisco Etchant with BAC
US Pat.5,385,728 (1995)
Conclusions: BAC is effective at inhibiting both soluble recombinant MMPs and matrix-bound dentin MMPs.
The Role of Matrix Metalloproteinases (MMPs) in Human Caries

C. Chaussain-Miller, F. Fioretti, M. Goldberg, S. Menashi

Abstract

The objective of this review is to summarize our understanding of the role of host matrix metalloproteinases (MMPs) in the caries process and to discuss new therapeutic avenues. MMPs hydrolyze components of the extracellular matrix and play a central role in many biological and pathological processes. MMPs have been suggested to play an important role in the destruction of dentin organic matrix following demineralization by bacterial acids and, therefore, in the control or progression of carious decay. Host-derived MMPs can originate both from saliva and from dentin. They may be activated by an acidic pH brought about by lactate release from cariogenic bacteria. Once activated, they are able to digest demineralized dentin matrix after pH neutralization by salivary buffers. Furthermore, the degradation of SIBLINGs (Small Integrin-binding Ligand N-linked Glycoproteins) by the caries process may potentially enhance the release of MMPs and their activation. This review also explores the different available MMP inhibitors, natural or synthetic, and suggests that MMP inhibition by several inhibitors, particularly by natural substances, could provide a potential therapeutic pathway to limit caries progression in dentin.
Under-cured Resin Composite

• Is linked to post-operative sensitivity

• Results in:
  – Increased wear & fracture
  – Reduced bond strengths
  – Secondary caries
  – Increased bacterial colonization
  – Color changes in resin
  – Increased leachates (cytotoxicity)
  – FAILURE
Evaluate Energy Delivery

MARC™ Patient Simulator quantifies energy delivery to resin

Consistently calibrated enables apples:apples comparisons

Scientifically accurate, clinically relevant & easy-to-use
There are Lots of Different Curing Lights

...and their CLINICAL PERFORMANCE is VERY different!
CLINICAL Irradiance

There’s no one number

- Beam profile and distance can have a very large effect.
- Irradiance commonly declines by 60 – 80% over clinically relevant distances
37 Operators
Same Light, Same Tooth, Same Time

Optimal is 8.0 J/cm²
Range from 0.9 – 7.2 J/cm²
Average was 4.1 J/cm²
### Energy Requirements

- Each shade requires a different amount of time as determined by the manufacturer.

<table>
<thead>
<tr>
<th>SHADE</th>
<th>SECONDS</th>
</tr>
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<tbody>
<tr>
<td>A2-O</td>
<td>20</td>
</tr>
<tr>
<td>BW</td>
<td>10</td>
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<td>U/LYG</td>
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<tr>
<td>C2-O</td>
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<td>M5</td>
<td>15</td>
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<td>M6</td>
<td>15</td>
</tr>
<tr>
<td>M7</td>
<td>15</td>
</tr>
</tbody>
</table>
Energy Requirements

DEMI- Demetron
995.00$

Less than 400 milliwatts “might be good for orthodontic brackets or sealants”
Energy Requirements

LED China
24.83$ total
Fully programmable

More than 800 milliwatts!
FDA approved???
UL listed?
Hospital cases
Energy Requirements

LED China
32.50$ total
Fully programmable

FDA approved
CE listed
Hospital cases
Energy Requirements

LED China
32.50$ total
Fully programmable

More than 1000 milliwatts!
FDA approved
UL listed?
Hospital case
Energy Requirements

• Don’t take chances with these sweet little snot nosed bundles of joy.

Governmental Regulations are always beneficial and logical. REALLY???
Ultrasonic Point Preparation
CVDentus

Minimally Invasive Dentistry
Ultrasonic Point Preparation
CVDentUs

- CVDentUs
- Brazilian company that produces dental diamond points for ultrasonic preparations.
- Based on space technology
Ultrasonic Point Preparation
CVDentUs

- Chemical Vapor Deposition - surface completely covered with diamonds
Ultrasonic Point Preparation
CVDentus

- CVD adaptors allow use with existing ultrasonic equipment

CVDentus tips

Download Catalogs:
- Português (365 KB)
- English (363 KB)

The biggest news in odontology also has the CVD technology.

It is the new CVDentus tips, adaptable tools in CVD-Diamond to equip existing ultrasound already in the dental doctor's offices. The great news is that these tools extend the use of the ultrasound equipment.
Ultrasonic Point Preparation

Compared to air abrasion, reportedly as comfortable for the patient during tooth preparation.

Removes carious dentin.

Less micro-leakage according to some studies.

Conservative preparation tips.
Ultrasonic Point Preparation
CVDentUs

- Small Table Top Piezo Electric Ultrasonic Unit
Ultrasonic Point Preparation
CVDentUs

- Small Table Top Piezo Electric Ultrasonic Unit
Ultrasonic Point Preparation
CVDentus

- Silver tips are for cutting
- Gold tips are for finishing
Eighteen Month Old Presents - with Enamel Defects of Molars and Incisors
Behavior - tentatively cooperative, short attention span, active
Oral Hygiene - greatly improved
Parental Attitude - very involved
Financial resources - large family, limited
Eighteen Month Old
Treatment- Fluoride Varnish, in office, MI Paste (Tooth Mousse), at home, applied by parent before nap and at bedtime (Repair)
ART with Fuji II LC (RMGI) and Triage (RRGI) while sitting on parent’s lap
Alternative Restorative Treatment

- Duraphat on canines and occlusal Triage on posteriors
- Just over two years old

Fuji II LC SCs
Alternative Restorative Treatment

• Many hypocalcific defects restored with Triage
• Must have a “clinically relevant” level of fluoride to be worthwhile
Beyond First Do No Harm: Principles of Atraumatic Care

Donna L. Wong, PhD, RN, PNP, CPN, FAAN

Definition of Atraumatic Care

Atraumatic care - is the provision of therapeutic care in settings, by personnel, and through the use of interventions that eliminates or minimizes the psychologic and physical distress experienced by children and their families in the health care system (Wong, 1989).

Therapeutic care - prevention, diagnosis, treatment, or palliation of chronic or acute conditions

Setting - any place care is given

Personnel - anyone involved in providing therapeutic care

Interventions - strategies aimed at reducing distress

Psychologic distress - may include anxiety, fear, anger, disappointment, sadness, shame, guilt, embarrassment, loss control, helplessness, hopelessness

Physical distress - may range from sleeplessness and immobilization to disturbing sensory stimuli, e.g., pain, temperature extremes, loud noises, bright lights

Identification of Child and Family Stressors

Physical Stressors
Preventive Dentistry: Alternative Restorative Treatment for temporarily restoring the dentition of a young patient, without local anesthesia and minimal emotional distress.

Evidence-Based Dentistry (2005) 6, 9. doi:10.1038/sj.ebd.6400018

Atraumatic restorative techniques contribute to discomfort in children receiving dental care.

Does the extent of discomfort differ between atraumatic restorative treatment of multisurface cavities in deciduous molars compared with use of rotary instruments?

Address for correspondence: MCM Schriks, Department of Cariology, Endodontology and Pedodontology, Academic Centre for Dentistry Amsterdam, Louwesweg 1, 1066 EA Amsterdam, The Netherlands. E-mail: m.schriks@acta.nl

Chris Deery

1Paediatric Department, University of Edinburgh, Edinburgh Dental Institute, Edinburgh, UK

The atraumatic restorative treatment (ART) approach to restoring primary teeth in a standard dental clinic

Honkala et al
International Journal of Paediatric Dentistry
2003;13:172-179

After a 2 year evaluation, no significant difference between ART and Amalgam restorations

Do no harm — but first, do not hurt

Raymond D. Pitetti

Dr. Pitetti is an Assistant Professor of Pediatrics in the Division of Pediatric Emergency Medicine at the Children's Hospital of Pittsburgh, Pittsburgh, Penn.

Correspondence to: Dr. Raymond D. Pitetti, Division of Pediatric Emergency Medicine, Children's Hospital of Pittsburgh, 3705 Fifth Ave., Pittsburgh PA 15213; fax 412 692-7464; raymond.pitetti@chp.edu

As recently as 20 years ago, many health care professionals believed that young children did not experience pain and that the use of opiates for pain control was contraindicated because of a substantial risk of addiction. A related misunderstanding was the belief that even if children experienced pain, they would not remember it, and therefore they would sustain no lasting effects. Another commonly held belief was that a child's pain could not be measured accurately. As a result, many clinicians performed painful procedures, including intravenous cannulation, on children without regard for the pain the child was experiencing.

Thankfully, we no longer hold to such archaic ideas. Neuroanatomic studies have shown that by 29 weeks of gestation, pain pathways and the cortical and subcortical centres involved in the perception of pain are well developed, as are the neurologic systems for transmitting and modulating painful sensations. Therefore, even fetuses can perceive pain in ways similar to those of an older child. In addition, studies have shown associated with painful procedures, can endure in the memory and result in, for example, disturbances to eating, sleeping and the stability of the stat can be assessed through physiologic indicators, systematic observation of behaviour, and reports by the children themselves. As a result, there has to pain and pain management in children.
Ultrasonic Point Preparation

CVDentUs

- CVDentUs
- Brazilian company that produces dental diamond points for ultrasonic preparations.
- Based on space technology
Ultrasonic Point Preparation
CVDentUs

• Small Table Top Piezo Electric Ultrasonic Unit

Que Bom!
Ela perdeu o medo de ir ao Dentista.
Great!
No more fear in going to the dentist.

Bem-Vindo à Odontologia Ultra-Sônica.
Welcome to Ultrasonic Dentistry.
Use as Pontas com o Profi.
Use the Tips with Profi.
Twenty four month old female with deep pit second primary molar

“Sensitive to explorer probing”

Partially erupted tooth with open contacts
Ultrasonic Point Preparation
CVDentUs

- Pumice prophylaxis - plaque debridement
Ultrasonic Point Preparation
CVDentUs

- Round tip ultrasonic point to access decay
Ultrasonic Point Preparation
CVDentUs

- Round diamond point is approximately the estimated size of diseased tissue
- Conservative access
Access is completed and the carious dentin (infected) removed with a small, sharp dental spoon excavator.
Ultrasonic Point Preparation CVDentUs

- Very hard dentin surface
- Slight pink blush
- No report of discomfort at all
- Conservative treatment
Ultrasonic Point Preparation CVDentUs

- Preparation conditioned with total etch technique
- Fuji IX Extra mixed by assistant in RotoMix (Espe)
- Injected into preparation
Ultrasonic Point Preparation CVDentUs

- Resin impregnated brush used to smooth restoration prior to set
- Resin placed upon etched enamel surface
Ultrasonic Point Preparation
CVDentUs

- Light curing of top resin layer
- Resin layer protects setting resin reinforced glass ionomer during the acid-base reaction
Ultrasonic Point Preparation
CVDentUs

- Finished restoration
- Adjacent fissure sealed with RRGI and resin coat
Ultrasonic Point Preparation
CVDentus

- Silver tips are for cutting
- Gold tips are for finishing
Ultrasonic Point Preparation
CVDentus

- Ultrasonic Dentistry
- Minimally Invasive Dentistry for Pediatric Dentists
Ultrasonic Point Preparation

CVDentus

• Ultrasonic Dentistry

Minimally Invasive Dentistry for Pediatric Dentists
Using tapered point for Partial pulpectomy
Restorative Care

• “Open Sandwich”
**Sandwich Technique**

- **Open sandwich**: exposed gingival component that releases fluoride, used in patients with higher caries incidence.
- **Closed sandwich**: fluoride releasing component not exposed to environment, used in deeper restorations.

*Issues*: degradation of dentin bond, water treeing
Clinical pre-operative view

- Distal lesion of first primary molar
Pre-wedge with wood wedge

- Wooden wedge pre-separates and protects dam/tissue
Preparation

• Rounded line angle

Facts do not cease to exist because they are ignored.

- Aldous Huxley
Sectional matrix and plastic wedge

- Proper placement requires:
- Sectional matrixes
- Plastics wedges
  - Five different sizes
Sectional matrix and plastic wedge

• Matrix too long
Total etch

- 32% phosphoric acid semi-gel

First on enamel
Then dentin
Adhesion of Resin Modified Glass Ionomer Restorations


Bond strength of RMGI to etched dentin

Fuji II LC - SBS = 19.7 MPa

Similar to many self etch adhesives
Capsule mixer

- Activate capsule and mix during etching of preparation
- Ref: Ewoldsen and Covey