Tooth Structure

Nature’s Best Restorative Material

A 30 Year Perspective

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TOOTH CONSERVING DENTISTRY

with advanced adhesive techniques

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"That which is worth doing is worth doing well"
Contacts

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Danville: http://danvillematerials.com
BioClear: http://www.bioclearmatrix.com
Photomed: http://www.photomed.net
Ultradent: https://www.ultradent.com
Ribbond: http://ribbond.com
Dentapreg: http://www.dentapreg.com/Dentists/Home
Brasseler USA: http://brasselerusa.com
Garrison Dental: https://garrisonental.com
Addent: http://www.addent.com

Education

David Clark, DDS: http://www.bioclearmatrix.com/events/
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David Alleman, DDS: http://www.biomimeticdentistryce.com
John Kois, DDS: http://koiscenter.com
Bioemulation USA: https://www.bioemulationusa.org
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More contacts listed on my website: http://ryoungdds.com/links.html
The graphics in the following slides were created by

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New Zealand
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modified for this lecture by ryoung

Effects of cavity designs on tooth flexure


courtesy g.milicich

RR: Rainey Ridges
PRF: Peripheral Rim Fractures
OEC: Occlusal Effect Caries

courtesy d.aleman
Peripheral Rim Fractures
From Sharp line angles of amalgam prep you will see
Dentin “Tension” Fractures

Marginal ridge fractures with class I amalgams

University of Zagreb, Croatia

<table>
<thead>
<tr>
<th>Restoration Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Restoration</td>
<td>4%</td>
</tr>
<tr>
<td>Composite</td>
<td>8%</td>
</tr>
<tr>
<td>Composite after previous Amalgam</td>
<td>28%</td>
</tr>
<tr>
<td>Existing Amalgam</td>
<td>42%</td>
</tr>
</tbody>
</table>

University of Ljubljana, Slovenia

49% (69/139) of molars with Cl. I amalgam had marginal ridge fractures. Correlation with age of amalgam.
Occlusal effect of caries milicich & rainey

- NOT all caries are caused from lack of flossing
- a peripheral rim fracture creates the 50-100 micron opening for bacteria to enter and replicate

And

Occlusal affects caries often start under occlusal cracks in adults. Not seen on x-ray until it’s more than 1/3 the width of the tooth

so what do you do?
Start ultra conservative

Grab
DIAGOdent
If we have to go larger we need to understand the "biobase"

Why is it so important

How do you do it
Polymerization shrinkage: it kills us in private practice

Methods:
- 2mm Deep Cavity
- Flowable Composite
- 7th Generation Single-Bottle Adhesive

Source: Tokyo Medical & Dental University

Laser Based, Optical Coherence Tomography System

CLEARFIL SE BOND 2

Scotchbond Universal

Estelite Flow Quick

Source: Tokyo Medical & Dental University

Nearly 100% Delamination of Composite to Bonding Agent or Bonding Agent from Dentin.
**Biobase Procedure:** This would be the same for any restoration involving composite, i.e., direct composite fillings, deep margin elevations, or indirect restorations.

Using Clearfil SE Bond 2 or Clearfil SE Protect

1. “Selective etch” all enamel, extending well past your finish line for “direct composite” restorations.
2. Rinse away your etch and dry.
3. Place the primer with a micro brush on all enamel, and dentin surfaces of the tooth. Thoroughly scrub the primer for 20-30 seconds.
4. Air dry the primer thoroughly. It is key to air the primer to dissolve off the water.
5. Place the Bond with a micro brush thoroughly coating all prepped enamel and dentin surfaces and scrubbing it in. Use a micro brush to soak up excess bond. You do not want “pooling” of the bond in the corners of your prep or box. You can also gently air the bond. However, you do not want to use forceful air which can thin the bond too much.
6. Light cure the bond for 20-30 seconds.
7. Place a very thin layer of “Majesty Flow A1 or A2” at the margin of the tooth-matrix interface. Move it as needed with the tip of an explorer or perio prob. This is a critical area and should be done first. Cure for 20-30 seconds.
8. Now place a very thin layer (no more than 1 mm) of “Majesty Flow” by Kuraray on the rest of the dentin. Distribute this evenly to all the dentin with an explorer, perio probe, or the ball burnisher end of the “Brucia” composite instrument by Brasseler. (TINBRU26 Composite Instrument, #: 5024754U0).
9. Light cure for 20-30 seconds.
10. Place a second layer of flowable if desired, again no more than 1 mm thick and light cure.
11. Place AP-X (heated if desired) in no more than 2mm increments until you reach your desired height. You can fill the whole restoration with AP-X or place and enamel layer with the posterior composite of your such, such as Heliomolar, Herculite, etc.

**Bulk fill option:**
Steps 1-10 are critical in doing a bulk fill restorations. You do not want to stress this part of the bonding process. Once these steps are complete you can use the bulk fill of your choice, such as Danville’s “Bulk EZ” composite.
"Adhesive dentistry could be expressed as a simple relationship between bonds and stress. If the bonds can withstand the stress, the restorative technique will be successful."

Unterbrink and Liebenberg (1999)
Bioclear Maytrix System
David Clark, DDS

“the dumming down of the diastema closure”
Richard Young, DDS
Biobase/Onlay Procedure: (the Biobase procedure would be the same for any restoration)

1. Take a quadrant impression of the tooth before preparation using a co-bite impression of your choice and a monophase VPS like Danville’s “First Quarter-Monophase” #89386.
2. Remove the old amalgam using a new bur imparting as little stress on the tooth as possible.
3. Evaluate the tooth, use “decay indicator” by Kuraray to check for decay areas. Remove with a round bur.
4. Round out the cracks with SS White Fissurotomy® bur #18910 or 18013. In larger areas you can use a round ended diamond like the KS 2 by Brasseler, to round out the crack.
5. Use a depth cutting bur by Brasseler to get accurate reduction for your onlay.

Place the “Biobase”

1. Use SE Bond or SE Protect bond. Rub in the “Primer” with a Micro brush for 30 seconds on all dentin and air dry thoroughly.
2. Place the “Bond” on the dentin with a Micro brush rubbing around thoroughly for 20–30 seconds. Damp up any excess with the micro brush. You do not want pooling of the bond.
3. Light cure the bond for 20–30 seconds.
4. Place a very thin layer (no more than 1 mm) of “Majesty Flow” by Kuraray. Distribute this evenly to all the dentin with an explorer, perio probe, or the ball burnisher end of the “Brucia” composite instrument by Brasseler. (TINBRU26 Composite Instrument, #: 5024754U0)
5. If you wish to place Ribbond or Dentapreg, place a very small amount of CLEARFIL AP-X (Kuraray) composite where you wish to place the fiber. Imbed the fiber into the AP-X and push into place the “Brucia” composite instrument #: 5024754U0. Once you have it placed where you want it soak it with bond carried over with the micro brush. Then light cure for 20–30 seconds.
6. Place additional “Majesty Flow” over the fiber and anywhere else you wish to have it to smooth out the prep or remove small undercuts. You should have coated all of the dentin when done.
7. Place “Liquid Lens” oxygen barrier over the restoration and light cure to eliminate the oxygen inhibited layer.
Prepare a chamfer margin in enamel creating a “compression dome” type restoration. This will also remove any bond that may have gotten on the enamel area during the biobase. Your prep is now finished and ready to scan or make an impression using your VPS of choice. I use Danville’s First Half “Black” #90467 in a “Mojo Syringe” #93735, and First Half “Green” Heavy Flex #93133 in the tray.

Fabricate a temporary using a lock on technique.
1. Vaseline the prep so the temp will release later.
2. Take your “quadrant impression” of the tooth before preparation and fill the prepped tooth area with “TurboTemp” by Danville, A2 #90344. Let this go to complete set, usually about 4 min.

Seating the Onlay:
1. Pop off the temporary. You may have to make a couple of cuts in the temporary and break it away. Be cautious to not cut the tooth itself, look at your die to see where to cut.
2. Try-in your restoration and adjust occlusion and contacts as necessary. With a correctly placed temp and a lab that fits the restoration on a “solid” model you should have very little to no contact adjustment.
3. Place a rubber dam including the prepped tooth and one tooth on either side. If you created you “deep margin elevation “ correctly and prepped supra gingival the placement should be very quick and easy with out a requirement for anesthesia. I use a 12A or 13A clamp for molars, and a bicuspid or anterior clamp as needed further forward.
4. Use a “MicroEtcher IIA” #22005–01, “MicroEtcher CD”, “MicroProphy II” #201684–00, or PrepStart H2O #91747, all by Danville Materials to clean and surface the preparation getting it ready for cementation. I prefer the “.032 Nozzle #186113 on the MicroEtcher IIA for this using “Aluminum Oxide” 27 micron #80042A, I have a unit hooked up to each chair via a quick connect. If you do not have any of these available or a similar type of device you can just total etch the tooth and proceed with your bonding of the restoration.
5. Cement the restoration with Panavia V5.
One SIMPLE & ESTHETIC Cement For All Your Needs

PANAVIA® V5 is a dual-cure, color-stable, fluoride-releasing resin cement with a single-bottle, simplified self-etching primer & a single-bottle universal restoration primer.

The new catalyst chemistry included in the tooth primer provides, for the first time in dentistry, self-cure bond strengths as strong as a direct light-cured, gold standard bonding agent (CLEARFIL SE BOND).

New Adhesive Milestone

The Combination of The Original MDP Monomer & New Proprietary Catalysts Provide:

A Self-Cure Resin Cement Dentin Bond Equal To A "Gold Standard" Light-Cure Bonding Agent
This research study by Bart Van Meerbeek and his staff at a Catholic University Leuven Belgium was with 3 self-etching primers made by Kuraray. Each primer was exactly the same content except for the MDP. One solution has the Original MDP by Kuraray then the other two are from PCM and DMI (USA and German mfgs. of MDP). This study also compared 4-Meta monomer from Sun Medical Inc. (makes Parkell products for USA) and also MHP.
With the new Panavia V5 unique catalyst chemistry, we are able to eliminate HF etching and just use K-Etchant syringe (35% phosphoric acid) to clean and activate e.Max restorations.
Clearfil Ceramic Primer Plus has the same chemistry as the original Clearfil Ceramic Primer, however, Kuraray has expanded its clinical applications to include metals so it is now a universal restorative primer. We still mfg. Alloy Primer for precious metals and we recommend it when doing repairs or when very high bonds are needed to precious metals.

In this clinical case immediate dentin sealing was done on the prep appointment, thus this image shows the K-Etchant syringe on the resin coated dentin and enamel not on dentin. With immediate dentin sealing, DDS should do one of the 2 following treatments to enamel and resin coated dentin:

1. Pumice enamel and the resin coated dentin then use phosphoric acid to clean the surfaces for 5 seconds rinse and dry.
2. Use air abrasion (Micro-Etcher) to roughen the resin coated dentin and enamel then use phosphoric acid for 5 seconds.
3. If a bonding agent only was used for Immediate Dentin Sealing, then pumice should be used and not air abrasion. Air abrasion can sandblast through a thin coat of bonding agent. Air abrasion can be used if a composite (flow or restorative) is being sandblasted.
Clinicians can have biting pain issues if the bonding procedure is not done properly.
1. The primer has to be applied and left for 20 seconds or rubbed in for 20 seconds
2. The primer must be air dried well to evaporate the water and get the water out of the bonding layer/hybrid layer.
3. If air drying is not done properly the material does not cure fully and can be weak.

Panavia V5 paste is approximately 12 microns in film-thickness, the previous Panavia resin cements are 19 microns thick.
We have compared Panavia V5 paste versus the main full strength resin cements on the market in regards to clean-up:
1. Panavia V5 is less sensitive to light,
2. RelyX Ultimate is very sensitive to light and can be very hard to clean-up
3. NX3 and Variolink DC have nice clean-up, however, they are more light sensitive than Panavia V5
the products that made so much of what follows possible

As well as the other “Gold Standard” Bonds

Kerr Optibond FL

Ultradent Peak

Average Annual Failure Rates 1950-2013
Clinical effectiveness of contemporary adhesives for the restoration of non-caries cervical lesions. A systematic review


2-Step Etch & Rinse 5.8
1-Step Self-Etch (Strong Acidity) 5.4
1-Step Self-Etch (Mild Acidity) 3.6
3-Step Etch & Rinse 3.1
2-Step Self-Etch (Mild Acidity) 2.5
Glass Ionomers 0 1.5 2 3 4.5 6

Annual Failure Rates %
For this type of tooth fracture do the following:

1. Clean the fragment and the tooth off with water spray, saline, or chlorhexidine then etch both with 35% phosphoric acid solution.
2. Apply SE Primer to both surfaces for 30 seconds and thoroughly air off the primer.
3. Apply SE Bond to both surfaces and put together. Light cure thoroughly from both the lingual and facial.
4. DO NOT PUT A FILLED COMPOSITE between the two pieces. Your pieces will NOT go back together like glass.
5. If you have a small chip in the enamel you can put a very small amount of flowable only where the void from the chip is. Do not put it where the two pieces fit perfectly.
6. You are bonding to mostly enamel, a very strong bond.

If there is a small pulp exposure the procedure would be the same accept to rinse gently with sterile saline solution, or chlorhexidine then dry gently. If there is bleeding you can stop the bleeding with a small amount of hemostatic solution from Ultradent on a cotton pellet.

For more information on handling of the pulp refer to IADT Website:

http://www.dentaltraumaguide.org/Permanent_enamel-dentin-pulp_fracture_Treatment.aspx
# The Five Most Important Research Papers For Adhesion Dentistry

1. Takao Fusayama 1978-1980
   - New Concepts in Operative Dentistry
   - Etching Dentin Article and 1st dentin adhesive (phosphate Monomer: Phenyl-p)

2. Setting Stress in Composite Resin in Relation to Configuration of the Restoration
   - Journal of Dental Research

3. Immediate Dentin Sealing
   - 1992 David Phile et al. Medical College of Georgia
   - 3b. Efficacy of Resin Coating on Bond Strengths of Resin Cement to Dentin.
   - 3c. Immediate Dentin Sealing Improves Bond Strengths of Indirect Restorations.

4. Influence of C-Factor and Layering Technique on Micro-Tensile Bond Strength to Dentin.
   - S. Nikitopenko et al. University of Erlangen-Nuremberg

5. Relationship Between Bond-Strength Tests and Clinical Outcomes,
   - “The Most Comprehensive Summary & Analysis of Long-Term Clinical & Laboratory Adhesive Research Results in the History of Adhesion Dentistry”

#1: New Concepts in Operative Dentistry 1980

- Introduced 2 Layers of Carious Dentin
- New Phosphate Monomer: Phenyl-p
- 1st Successful Dentin Bond
#2: C-Factor (Stress) 1987

What is “C-Factor”

C-Factor means **Configuration Factor**
How is it Calculated:

\[
\text{C-Factor} = \text{“The ratio of bonded to un-bonded (free) surfaces”}
\]

Felzer, DeGee, Davidson (1987); University of Amsterdam, ACTA

Lowest Stress - Veneers

Low Stress

Medium Stress

High Stress - Class II

Highest Stress - Class I

“Adhesive dentistry could be expressed as a simple relationship between bonds and stress. If the bonds can withstand the stress, the restorative technique will be successful.”

Unterbrink and Liebenberg (1999)

#3: Immediate Dentin Sealing

Operative Dentistry, 1992 Jan-Feb;17(1):13-20
Dentin Permeability: Sealing the Dentin in Crown Preparations
Pitting B, Garner AW, Proctor MS; Hume J, Teelke DM, Geerhan VM
Medical College of Georgia, School of Dentistry

Abstract

Provisional restorations of full crowns preparations may permit more microleakage of bacteria and their products than the final castings do. However, most investigations of the sealing qualities of cemented crowns have reported that they too permit leakage. One approach to the problem is to seal the dentin with dentin bonding agents at the completion of the crown preparation. This study evaluated the ability of six different dentin bonding agents to seal the dentin of crown preparations of human teeth in vitro using two independent techniques. The first technique quantized fluid motion across dentin before and after treatment with dentin bonding agents at one hour, one day, one week, and one month and after thermo-cycling. The second method measured silver nitrate penetration of the pin wipers of dentin bonding agents into the dentin. Both methods correlated well with each other. The best results were obtained with Primar XAM, Heliobond, and ScotchBond 2 gave intermediate results. Although the dentin bonding agents tend to accumulate on chamfers, thereby increasing their thickness to 100-300 microns, the method looks promising as a simple way to protect the pulp from the consequences of micro-leakage.
Efficacy of a Resin Coating on Bond Strengths of Resin Cement to Dentin

Primal R. Jayasooriya, BDS
Patricia N. R. Pereira, DDS, PhD
Toru Nishida, DDS, PhD
Junji Tagami, DDS, PhD

Purpose:

The aims of this study were to:

1. Evaluate the effect of a resin coating consisting of a dentin bonding system and a flowable resin composite on the microtensile bond strength (µ-TBS) of a resin cement to dentin with indirect composite restorations and

2. Compare the bond strengths of direct and indirect composite restorations.

Materials & Methods:

Occusal surfaces of human premolars were ground to obtain flat dentin surfaces and were divided into seven groups. For indirect restorations, the dentin surfaces of the experimental groups were bonded with a dentin bonding system (DBS), CLEARFIL SE BOND (SE) or Single Bond (SB) with and without a flowable resin composite, PROTECT LINER F, temporized for one day and cemented with a resin cement (PANAVIA F) according to the manufacturer’s instructions. The dentin surfaces of the control group were temporized without prior treatment and indirect composite (ESTENIA) was bonded with PANAVIA F. For the direct restorations, either CLEARFIL SE BOND or Single Bond was applied to the dentin surface and the entire surface was built up with a direct composite (CLEARFIL AP-X). After 24 hours in water storage, µ-TBS was measured at a crosshead speed of 1 mm/min.
Results:

The original bond strength of the resin cement (PANAVIA F) to dentin significantly improved with the use of a resin coating technique with indirect restorations. The combination of dentin bonding systems plus PROTECT LINER F showed significantly higher bond strengths compared with the single use of dentin bonding systems. The combination of CLEARFIL SE BOND & PROTECT LINER F as a resin coating provided the highest bond strengths with indirect restorations.

However, the best bond strengths were observed when CLEARFIL SE BOND & Single Bond were used for direct composite restorations.

Immediate Dentin Sealing Bond Strengths (MPa)

Conclusions:

The application of a resin coating consisting of a dentin bonding system and a flowable resin composite on the dentin following cavity preparation significantly improved the $\mu$-TBS of the resin cement PANAVIA F to dentin with indirect restorations. However, the bond strengths of indirect composite restorations were significantly lower than those of direct composite restorations even with the resin coating technique.

“If indirect restorations are selected, a resin coating consisting of a dentin bonding system and flowable resin composite should be applied to the dentin surface to improve the bond strengths of resin cements to dentin.”

Failure / Fracture Modes:

<table>
<thead>
<tr>
<th>Bond Strength (MPa)</th>
<th>@ Cement / Dentin Interface</th>
<th>Between Resin Coating &amp; Cement</th>
<th>Failure In The Resin Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANAVIA F</td>
<td>10.3</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>SE Bond + PANAVIA F</td>
<td>17.7</td>
<td>0%</td>
<td>80%</td>
</tr>
<tr>
<td>Single Bond + PANAVIA F</td>
<td>20.8</td>
<td>0%</td>
<td>80%</td>
</tr>
<tr>
<td>SE Bond + Flowable + PANAVIA F</td>
<td>42.5</td>
<td>100%</td>
<td>0</td>
</tr>
<tr>
<td>Single Bond + MP-F</td>
<td>42.5</td>
<td>100%</td>
<td>0</td>
</tr>
</tbody>
</table>

Where Do The Bonds Fail?
Layering Concepts


Influence of C-Factor and Layering Technique on Micro-Tensile Bond Strengths To Dentin

#4: 2003

#5: "The Relationship Between Bond Strength Tests and Clinical Outcomes"
Dental Materials Journal 2010
B. Van Meerbeek, M. Peumans, A. Poitevin, A. Mine, A. Van Ende, A. Neves, J. DeMunck

Methods:
• Reviewed over 1,700 Laboratory Adhesive Bond Tests
• Reviewed 1453 papers of Clinical Class II & III Treatment Studies
• Updated Clinical Review Analyzed 27 Years of Clinical Studies

Conclusions:
• “Altogether, when bonding to both enamel and dentin, selective etching of enamel followed by the application of the 2-step self-etch adhesive to both enamel and dentin currently appears the best choice to effectively and durably bond to tooth tissue.”
2009 Data

Average Annual Failure Rates 1950-2013
Clinical effectiveness of contemporary adhesives for the restoration of non-carious cervical lesions: A systematic review
1950 - 1959: 0.3%
1960 - 1969: 1.1%
1970 - 1979: 1.8%
1980 - 1989: 2.5%
1990 - 1999: 3.2%
2000 - 2009: 3.9%
2010 - 2013: 4.6%

- Excellent Desensitizer
- Antibacterial (Cavity Cleansing)
- Deactivates MMP Enzyme
  (One of the causes of dentin bond degradation)
- Unique “Encapsulated Fluoride Release” (Creates “Super Dentin Layer”)

Product Source: Your Dental Supplier
The 3 Must Haves

Product Source: Your Dental Supplier