In the name Of God
Bonding: Current Aspects And Clinical Approaches

Presented By:
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Dental Adhesive systems

Main Challenge in Adhesive Technology
Minimally Invasive Dentistry Technique Sensitivity
Rapid Debonding
Early Marginal Degradation
Main Causes of Failures:

Tooth Heterogeneity
Dentin Hydrophilicity
Features after Cavity Preparation
Characteristics of the Adhesive
Strategy of interaction with Dentin
Interaction with Dental Hard Tissue

Exchange Process

*Enamel*

*Dentin*

- Heterogeneous Nature
- Dentinal tubules
- Smear Layer
-Gold Standard Adhesives

*Etchant, Primer, Adhesive Resin*

-Demand for Simplification

- *Two or Three steps Etch & Rinse Adhesives*
  *Combination of Primer and Bonding Resin*

- *One or Two Steps Self Etch Systems*
  *Combination of Etchant and Primer*
  *Combination of Etchant, Primer and Bonding Resin*
Annual Failure of Bonded Restorations (Decreasing Order):

One step self-etch >
Two steps etch- and – rinse >
Two steps self etch (Aggressive) >
Three steps etch- and-rinse >
Two steps self etch (Mild) 

(Van Meerbeek et.al. 2010)
Etch & Rinse Approach
Three-Step Etch & Rinse Adhesives

All-bond2, Bisco
Optibond, Kerr
Optibond FL, Kerr
Scotch Bond Multi Purpose, 3M/ESPE
Permagen, Ultradent
Permaquik, Ultradent

Two-Step Etch & Rinse Adhesives

Solo Bond M, VOCO
Single Bond, 3M/ESPE
Prime & Bond 2.1, Dentsply
Prime& Bond NT, Dentsply
Opti Bond Solo, Kerr
Opti Bond Solo Plus, Kerr
PQ1, Ultradent
One Step, Bisco
One Coat Bond, Coltene
XR Bond, Kerr
Excite, Vivadent
Etch and Rinse Approach

Initial Step
Dentinal Changes

Second Step

Third Step
Micromechanical Simplification

Results of Simplification:
Insufficient Resin Infiltration
Nanoleakage

Inorganic phase Demineralization depth
Incomplete Infiltration of Resin due to:

Presence of residual solvent
Fluid movement out of dentinal tubules

Nanoleakage
Technique Sensitivity of Etch and rinse Adhesives

Dry Dentin
Excessively Drying Dentin: Network Collapse

Excessively Wet Dentin: Phase Separation

Effects of Adhesive Solvent
Acetone Based Adhesives
Water Based Adhesives
Acetone Based Adhesives

Wet Bonding Technique

How Moist Should be Dentin?

Over Dry and Over Wet Conditions

The dentin surface should be gently air dried until the etched enamel presents in its white frosted appearance and dentin loses its shine and turns dull.

Rewetting with water or chlorehexidine

One Step, Bisco: Acetone Solvent
Prime & Bond, Dentsply: Acetone Solvent
All Bond 2, Bisco: Ethanol/Acetone Solvent
In contrast with acetone based adhesives, water based adhesives appear to be less sensitive to variations in the bonding protocol.

- Optibond, Kerr: Ethanol/Water
- Scotch Bond Multi Purpose, 3M: Ethanol/Water
- Single Bond, 3M: Ethanol/Water
- Solobond M, VOCO: Ethanol/Water
Water Based Adhesives

Note

“Any remaining solvent should be evaporated from the dentine surface by drying the applied primer/adhesive”

To facilitate the evaporation of the solvent in water based adhesives, ethanol and acetone can be used with water as Co-Solvents.

Tert-Butanol Solvent: XP Bond, Dentsply
The Problem of Residual Solvents

- Optimum thickness of adhesive layer
- Is it enough to air dry adhesive for 3-5 seconds?

Use of Solvent Free Adhesives
The hybrid layers created by Etch & Rinse adhesives undergo degradation within 6 months to 3-5 years.
Factors that Compromise the Durability of Resin-Dentin Bonds:

- Hydrolytic degradation by water sorption
- Incomplete infiltration of resin monomers
- Collagenolysis by endogenous MMPs
Strategies to Prevent Degradation of Resin-Dentin Bonds:

- Inhibition of collagenolytic enzymes
- Ethanol wet bonding with hydrophobic resins
- Biomimetic remineralization of resin-dentin bonds
Inhibitors of MMPs

Chelation of Ca^{++}

Glutaraldehyde: *Crosslinking*

Galardin & Chlorehexidine (2-0.2%)

Benzalkonium chloride

Ethanol (Ethanol wet bonding)
Ethanol Wet Bonding Technique

-Solvent in 2 Step Etch and Rinse Adhesives
-Chemically Dehydration by Ethanol
-Changes in Collagen Network
-Intimate Contact with Collagene Fibril
-Hybrid Layer Degradation
Importance of Peripheral Enamel

Studies by Armstrong, Pashley and Gamgorgi on Dentinal Bond Strength of 2 step etch & rinse systems

Phosphoric acid etching of dentin could nowadays be considered too aggressive
Is There A Role for Therapeutics in Dentin Bonding?

- Adding BAC to Acid Phosphoric Acid
- Adding Chlorehexidine to the Primer
- Using Solvent Free Adhesives
Although 3-step etch & rinse adhesive systems are the oldest of the marketed adhesives, their separation of key ingredients offer more therapeutic flexibility than simpler combination adhesives.
Etch & rinse adhesives that utilize 3 steps are more durable than 2 steps.
Major shortcomings of etch & rinse systems

- Separate etching step
- Technique sensitive
- Post operative sensitivity
- Hydrolytic degradation
- MMPs degradation
- Lack of ionic bonding
I'd rather go to the dentist... but I'm going.
Self Etch Approach
General characteristics of self etch adhesives:

- Not require a separate etching step
- Smear Layer Interaction
- Simultaneously condition and prime
- Less technique sensitive
- Lower incidence of post operative sensitivity
- Less aggressive
- Concerns about effectiveness especially durability
Self Etch Adhesives

Two Steps
- Futurabond M, VOCO
- Adhe SE ONE F, Vivadent
- iBond, Heraeus Kulzer
- Xeno IV, Dentsply
- S3Bond, Kuraray

One Step
- Two Components
- Single Component
Two Steps

Clearfil Liner Bond 2V, Kuraray
Clearfil SE Bond, Kuraray
NRC&Prime&Bond NT, Dentsply
F2000, 3M
Unifl Bond, GC
Opti Bond(no erch), Kerr
Opti Bond(no erch), Kerr

Separate use of acidic primer and bonding resin
One Step

Two Components

First: Mixing two components and then applying the mixed adhesive on tooth surface

Futurabond DC, VOCO Adhe SE, Vivadent One-Up Bond F, Tukuyama Dental Prompt L-Pop, 3M/ESPE
Futurabond DC

Dual. Universal. Safe
Composition

Liquid A:
- Polyfunctional Adhesive monomers
- Dimethacrylates
- SiO2-Nanoparticles
- Initiators

Liquid B:
- Ethanol
- Water
- Fluorides
- DC Catalyst
Application
Application (indirect)
They consist of one bottle only

**No need** for mixing components
Futurabond M

7th Generation: 1 Bottle Self-etch Bond
Application
Application
Application
PH Based Classification

**Strong:**  *Xeno IV and Prompt L-Pop*
- PH: 1
- Interaction Depth: Several micrometers
- Interfacial Integrity: Ca depositions
- Dentine and Enamel Bond Strength
- Bond Durability

Avoid “Strong” Self Etch Adhesives

**Intermediate:**  *iBond*  PH: 1.5

**Mild:**  *Clearfil SE Bond*  PH: 2

**Ultra Mild:**  *S3 Bond*  PH: 2.7
Chemical Bonding by Self Etch Adhesives

- Functional monomers: 10-MDP, 4-META and Phenyl P
- Stability of 10-MDP bond
- Clearfil SE Bond (Kuraray)
- Bonding effectiveness of self-etch adhesives

Simultaneous infiltration of etchant and primer

- Effect of Smear layer:
  Thickness, Density and Degree of Attachment

- Adhesion to enamel
  Beveled cavosurface margins
  Selective etching of enamel
  Enamel marginal defects

Phosphoric acid etching of dentin could nowadays be considered too aggressive for dentin.
One-Step Self Etch Adhesives

- Less application time
- More acidic and hydrophilic solutions:
  
  *HEMA: Semi-permeable membrane*
  - Lower immediate bond strength
  - Water filled channels

**HEMA free one step self etch adhesives**

Phase Separation Problems
Concerns about One-Step Self Etch Adhesives:

Problems:
- Variety of unrelated problems
- Reduced immediate bond strength
- Lower long term effectiveness
- Increased interfacial Nano-leakage
- Shelf life
- Inferior clinical performance
Annual Failure of Bonded Restorations (Decreasing Order):

One step self-etch
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Three steps etch- and-rinse
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(Van Meerbeek et.al. 2010)
Multimode or Universal Adhesive Systems

- Ability to bond methacrylate based restoratives, cement and sealant materials to dentin, enamel, glass inonomer, metals, zirconia, alumina

- Functional acidic monomer:
  
  **MDP**: Methacryloyloxy decyl dihydrogen phosphate

  Chemical bond to hydroxyapatite crystals and zirconia

  Resistance to biodegradation
Universal Bonding Systems
OptiBond XTR self-etch, light-cure universal dental adhesive stands apart as the only bonding agent that embodies both the power and durability of a total-etch adhesive and the simplified protocol of a self-etch technique. Universal compatibility enables use for all direct and indirect restorations. The unique chemistry of an enhanced self-etch primer and optimized adhesive in this 2-bottle system brings outstanding bond strengths to uncut enamel and dentin.
ALL-BOND UNIVERSAL is the first TRULY UNIVERSAL dental adhesive that combines etching, priming and bonding in ONE bottle. ALL-BOND UNIVERSAL is an ethanol/water-based dental adhesive which bonds to dentin and to cut and un-cut enamel. Unlike other one bottle adhesives, ALL-BOND UNIVERSAL is engineered for use for both directs and indirects, bonds to all indirect substrates, and is compatible to all composite and resin based cements without an additional activator.

For use on both direct and indirect restorations.
High bond strengths to all indirect substrates including: metal, glass, ceramics, zirconia, alumina, porcelain (silica-based), and lithium disilicate. Designed to be fully compatible with light-cured, self-cured and dual-cured composite and cement materials.
Bonding light-cured composite or compomer for all classes of direct restorations.
Root surface desensitization.
Sealing of dentin prior to amalgam restorations.
Protective varnish for glass ionomer restorative materials.
*Repair* of composite or compomer restorations.
Bonding sealants. Indirect Placement Indications:
Bonding *veneers* with RelyX™ Veneer Cement.
Adhesive/primer for chemical adhesion when bonding zirconia, alumina, metal or glass ceramic restorations.
Intraoral repair of existing indirect restorations.
Bonding self- or dual-cure core build-up materials and resin cements (with Scotchbond™ Universal DCA Dual Cure Activator).
Sealing of dentin prior to temporization for indirect restoration placement.
Clearfil SE Bond has been proven to yield reliable results in terms of “bonding effectiveness” and “durability” when compared to other commercially available self etch adhesives.
The ‘AD-Concept’ revisited as basis of durable bonding

Functional Monomers
-10-MDP, 4-META and Phenyl P
-Effectiveness and Stability

Importance of keeping hydroxy apatite at interface to protect collagen and generate chemical interaction receptiveness
**Bonding to Enamel**
Etch-and–rinse approach is preferred

**Bonding to Dentin**
Two steps mild self etch approach is superior

**Bonding to both Enamel and Dentin**
Selective etching of *enamel*
Followed by the application of the two steps mild self etch to both *enamel* and *dentin*
Therefore, it is highly recommended to **combine** selective etching of enamel margins with phosphoric acid and application of a mild two steps self etch in dentin.

( Van Meerbeek B., Yoshihara K., Yoshida Y., De Munke J., Dental Materials 27, 2011 )


Trust me, I'm a Dentist.
Thank you for your attention
In the Name of God
Restoration of Endodontically Treated Teeth

Dr. Kamyar Fathpour
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Restoration of Endodontically Treated Teeth
Restoration of Endodontically Treated Teeth

- Prognosis and Decision to use a post
  
  \textit{Primary purpose of post placement}

- Long term clinical success:
  
  \textit{Reasons of failure: Restorative treatments}

- Parameters
  
  \textit{Position of tooth, Occlusion, Function, Remaining tooth structure, Canal configuration}
Indications for Placement of Posts

-Post Risks: *Root fracture, Destruction, Straight crown down technique*

-Peroz Classification:

  **Class I:** 4 remaining walls  
  *No Indication of post, %50 Structural stability decrease*

  **Class II:** 3 remaining walls  
  *No Indication of post*

  **Class III:** 2 remaining walls  
  *No Indication of post, Better to Crown %63 Structural stability decrease*

  **Class IV:** 1 remaining wall  
  *Indication of post*

  **Class V:** No remaining wall  
  *Indication of post*
Importance of marginal ridge preservation
Effect of post on fracture resistance
Minimum thickness of 1mm
Minimum height of 2 mm for Ferrule Effect

Figure 1. Schematic representation of specimens in groups 2, 3, 4 and 5 (from left to right). The coronal portion was reduced to a flat plane at heights of 0, 1, 2 and 3 mm, respectively, from the cementoenamel junction (proximal, buccal and lingual aspects).
Indications for Placement of Posts

Anterior teeth:
- Shear forces
- Post indication: **Complete Coverage**
  - Maxillary Centrals and canines
  - Maxillary lateral and mandibular incisors
Indications for Placement of Posts

Posterior teeth:
- Vertical Force
- Retentive Features: Chamber retention, Amalgapins, Threaded pins
  Horizontal pin, Cost effective treatment
- Abutments: Indication of post
Indications for Placement of Posts

Maxillary premolars:
- Shear and compressive forces
- Post indications:
  - Crown length/diameter ratio
  - Lateral forces
- Use of tapered posts: more conservative
Considerations in post design

- Post design: Active threaded, Parallel, Tapered
- Retention, Canal length and configuration
- Post length
- Post diameter
- Venting
- Surface roughness
- Canal preparation
- Cementation
- Post Material
- Luting cement: Composite cements problems
Types of posts

- Custom cast posts:
  - Disadvantage: Tooth fracture resistance, Cost and time
  - Indications

- Prefabricated posts:
  - Canal length and wedging effect

- Posts:
  - Passive tapered
  - Passive parallel

- Parapost

- Active posts:
  - V-Lock
  - Flexipost
  - Vertical fracture

Passive tapered Posts: Canal length and wedging effect
Nonmetallic Post Systems

-Carbon Fiber Posts:

-Advantages: Bonding and Modulus of elasticity

-Disadvantages: Color, Radiolucency, Debonding
Nonmetallic Post Systems

-Tooth Colored Posts

Zirconium coated carbon fiber: Aesthetic Plus

Zirconium posts: Not etchable, Fractures (Cosmopost, Cerapost)

Fiber reinforced resin posts: Care for extensive destruction, (Fiber Kor, Luscent Anchor, Light Post) Glass Fiber or quartz
Fiber reinforced resin posts:

- Resistance:
  - Adhesive, Luting agent, Setting Process
  - Failure and causes: High degree polymerization (DT light post, Style post)
  - Luting agent: Conventional resin cements (Panavia, Calibra), Self adhesive cements (Maxcem, Biscem, Bifix)
- Adhesive - Setting process: Translucent posts, Air abrasion & Silane - Chemical interaction
The Retention Triad

Post Length: *Tensile and Pulling Forces*

Post Style: *Canal Length & configuration*

Luting Agent
The Resistance Triad

Crown Bevel: *Crown lengthening*

Vertical remaining structure

Anti rotation: *Round canals*
Build-up Material

Characteristics of the Ideal Core Material

- Stability in a wet environment
- Ease of manipulation
- Rapid, hard set for immediate crown preparation
- Natural tooth color
- High compressive strength
- High tensile strength
- High modulus of elasticity (rigidity)
- High fracture toughness
- Low plastic deformation
- Inert (no corrosion)
- Cariostatic properties
- Biocompatibility
- Low cost
Build-up Material

**Glass Ionomer:** *Fluoride, Easy, Color, Biocompatible, Corrosion resistance, Low Fracture Toughness, Cracks*

**Composite resin:** *Easy, Color and contrast, Compressive strength, Fracture toughness, Plastic deformation, Unstable dimension, Polymerization shrinkage*

**Resin Modified Glass Ionomer:** *Low strength*

**Amalgam:** *Low early strength, Discoloration*

**Cast Metal:** *Gold casting posts*
Use Amalgam or Custom Cast posts in high stress areas or large replacement of tooth.

Do not Use Composite resins when replacing Teeth with no vertical wall.
Definitive Restorations

-Anterior Teeth:

Composite resin restoration: *Class I*

Bonded Porcelain Veneer: *Class II & III*

Crown: *Class IV and V*

*Use posts specially for maxillary lateral and mandibular incisors*
Definitive Restorations

-Posterior Teeth:

*Cuspal Coverage with crowns and Onlays*

*Composite resin: Functional loading and Thermal cycling, Sensory feedback*
Conclusion

1. If posts are indicated, use *small diameter* and passive round posts.
2. Consider *1/1 ratio* of crown length to post length.
3. Better to use *conventional cements* such as zinc phosphate or resin modified glass ionomer
4. Consider post length of *2/3* root length and *4mm gutta percha* in the canal.
Conclusion
References

3. Quintessence International;36,9,2005
Thank you for your Attention