

Make it **STICK!** Predictable and Durable Adhesive Dentistry

Edmond R. Hewlett, D.D.S.

Bonding to Enamel

- High inorganic (Hydroxyapatite) content
 - range: from 86% up to 98% HA in mature enamel
 - consistent, homogeneous structure
 - ∴ **Enamel is a very predictable resin bonding substrate**
- Etching Enamel
 - Phosphoric acid (H₃PO₄), 32%-35%: IDEAL
 - Increases bonding surface area
 - Cleans debris and contaminants
 - **Bonding to etched enamel is very predictable/durable**
- Selective Etching (for Self-Etching adhesives)
 - Self-etching adhesives: minimal etch of enamel – adequate?
 - PRE-ETCH enamel w/phosphoric acid for best seal
 - Etch ONLY the enamel margins
 - Etch 30-45 seconds, rinse and dry thoroughly
- *Aprismatic* enamel at surface
 - must instrument surface to expose prisms for optimal bonding
 - use a coarse composite finishing disk
 - disk beyond the bevel
- White Lines at margins
 - Enamel cohesive failure
 - Space fills with polishing debris
 - Proximal margins: BEVEL
 - Occlusal margins: REMOVE SHARP EDGE
 - Remove unsupported enamel
 - Disk beyond the bevels
 - Etch with phosphoric acid
 - 30-45 sec. on *enamel*
 - Rinse thoroughly
 - WAIT 5-10 min. before finishing restoration margins

Bonding to Dentin

Dentin as a Bonding Substrate

- *COMPLEX* structure
 - Less HA (45%-65%) than enamel, PLUS collagen, tubules, water, tubular fluid, noncollagenous proteins
 - Direct connection to the pulp (via tubules)
 - "The general practitioner should handle dentin as a dynamic continuum of the pulp." (P. Lambrechts)
- Confusing array of products and techniques

- **COMPLEXITY + VARIABILITY = dentin is NOT a very predictable resin bonding substrate!**
 - Variable morphology – tubule density
 - Variable degree of mineralization
 - Intertubular dentin (less mineralized) vs. Peritubular (Intratubular) (more mineralization)
 - shallow dentin: more intertubular, more “etchable”
 - deep dentin: more peritubular, more acid resistant
 - Sclerotic dentin – HYPERmineralized!
 - How to optimize the bond?
 - Prepare? Longer etch? Glass ionomer v. resin?
 - Carious dentin – partially (?) DEmineralized
 - Dentin as a Bonding Substrate – Summary:
 - No such thing as “*NORMAL dentin*”
 - Substrate variability = Bonding variability
 - Don’t be complacent!
 - Durability of Resin-Dentin Bonds
 - Dentin bonds made with newer simplified hydrophilic adhesives are subject to deterioration over time from
 - Hydrolytic breakdown
 - water sorption during and after bonding (Nanoleakage)
 - hydrolytic breakdown of resin and collagen
 - Degradation of demineralized collagen matrix by *host enzymes* (matrix metalloproteinases, or MMPs)
 - rinsing w/ 2% chlorhexidine cavity disinfectant between etching and resin placement may prevent this!

Dentin-Resin Bonding: What Can We Use?

(ALL systems employ variations of the following three steps)

- Acidic Conditioner (Dentin Etching)
 - removes smear layer, dissolves HA at dentin surface → exposes collagen fibers
 - opens tubules (dissolves smear plugs), widens tubule openings (funnel shape)
 - renders dentin surface highly *permeable*
- Hydrophilic Primer
 - hydrophilic resin monomer dissolved in a hydrophilic solvent
 - hydrophilic properties imparted by –OH and –COOH functional groups
 - diffusion of resin monomers into collagen fiber scaffold
 - formation of "Hybrid Layer" or "resin interdiffusion zone" composed of resin + collagen
 - penetration of monomers into tubules and tubule branches (resin tags)
 - conversion of surface from hydrophilic to hydrophobic
- Adhesive resin
 - stabilization of monomer-infiltrated (hybrid layer) dentin
 - copolymerization with the composite resin

II. The Products



III. Clinical Technique Considerations

- Dentin "Wetness" (NOTE: this applies ONLY to etch & rinse adhesives)
 - *Overdrying* of etched surface → collagen fiber collapse → ↓↓ *permeability!*
 - if not addressed: no resin diffusion, no hybrid layer, no resin tags, NO BOND!
 - *wet surface is critical for Acetone-based primers*
 - *Overwet* dentin → voids in bonded interface
 - optimal "wetness" is *critical for Acetone-based primers*
- Avoiding collagen collapse
 - Don't overdry – *blot dry* instead of using compressed air
 - suction-off excess water after rinsing, then use cut 2x2 non-linting gauze or dry applicator to absorb remaining excess in prep
 - overdried? re-wet with water and blot
 - Ethanol- or Water-based primers (simultaneous rewetting and priming)
- Rewetting agents
 - water
 - cavity cleaners, e.g. Consepis® (2% chlorhexidine) (Ultradent) or Tubulicid Red® (EDTA + benzalkonium chloride + NaF) (Global)
- Self-etching primers
 - usually dissolved in water
 - less sensitive to dentin wetness/dryness
 - most work best on DRY dentin

- Don't rush the priming step!
 - Apply/agitate for 30 seconds
 - Need **TIME** for resin interdiffusion into dentin
 - Facilitates evaporation of solvent
- "Air dry" = evaporate remaining water or solvent with compressed air
 - use GENTLE air stream to avoid displacement of primer monomer
 - dentin surface will still appear shiny due to presence of resin
- Sequential Etching (for Etch & Rinse adhesives)
 - **Avoid overetching dentin!**
 - Etch enamel for 30-45 seconds
 - Etch dentin for 5-10 seconds
- Isolation
 - moisture control is *critical!*
 - high surface energy of etched enamel is attractive to *all* liquids (water, saliva, blood, sulcular fluid)
 - *biofilm* contamination will result in reduced wettability of a hydrophobic adhesive

BONDING CHECKLIST – Etch & Rinse (4th or 5th generation)

1. Etch...
 - enamel for 30-45 seconds
 - dentin for 5 seconds
 - Rinse thoroughly (5-10 seconds)
 - **BLOT** dry (don't overdry!)
 - primers need **MOIST** dentin surface
 - **re-wet** and blot dry if necessary
 - Apply 2% chlorhexidine for 2 min., then blot dry
2. Prime...
 - Don't dispense until needed!
 - Re-cap bottle IMMEDIATELY (EVAPORATION!)
 - Apply and agitate
 - RE-apply and agitate
 - GENTLY air dry for 10 seconds
 - Not shiny? Re-apply and dry
3. Bond (apply adhesive resin)...
 - SLIGHTLY air thin
 - Cure for 20 seconds

BONDING CHECKLIST – Self-Etch (6th or 7th generation)

- *Selective enamel etch with phosphoric acid*
 - 30-45 seconds
- Apply 2% chlorhexidine for 2 min., blot/air dry
- Apply primer per mfr.'s DFU
- Apply/cure resin per mfr.'s DFU

Resin-Dentin Adhesion: Neutralizing the Variables – Part I

Posterior Composites: Risk factors for restoration longevity

- Size of restoration
 - Larger outline → higher risk of wear
 - Larger volume → resin/dentin interface is at risk (*shrinkage stress* at composite-dentin interface)
- Site
 - More posterior → more force during function
- Opposing occlusion
 - “plunger” cusp → force is concentrated in a small area
- Configuration (“c”) -factor
 - c-factor = ratio of bonded surface area to unbonded (free) surface area
 - e.g. flat dentin surface: $c=1$; occlusal Class I cavity: $c\cong 5$
 - higher c-factor → higher polymerization contraction forces on walls
 - Compensating for a high c-factor:
 - incremental insertion of composite
 - very small 1st increment
 - flowable composite as 1st increment
 - lower shrinkage stress and higher elasticity than packable/sculptable hybrids
- *Bulk Fill* Flowable Composite
 - Lower shrinkage stress
 - Higher depth of cure
 - Excellent radiopacity