

*****Handout*****
Adhesive Dentistry
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Dentin Bonding

* Regardless of the type dentinal adhesive used, the primary mechanism for dentin adhesion is still establishment of the hybrid layer. As seen below in the elegant TEM from Dr. Bart Van Meerbeek, the hybrid layer is a resin-reinforced layer that “connects” the underlying intertubular dentin to the adhesive resin (Fig. 1).

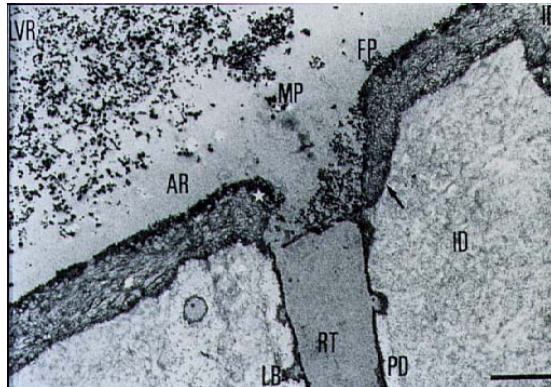


Figure 1

* For traditional dentin bonding techniques (etch and rinse systems) that require “wet bonding,” the dentin must not be dehydrated at the time of primer application, or bond strengths will be compromised.

MMPs

MMPs are matrix metallo proteinases, which are nascent dentin enzymes that if activated can result in proteolysis and degradation of the collagen, thereby reducing bond strengths to dentin. **Chlorhexidine has been shown in short-term clinical trials to inhibit the effects of MMPs, but the glutaraldehyde in materials like Gluma or G5 has been shown to do the same, making these materials far more preferable, since, unlike chx, they also offer profound desensitization due to tubular sealing (see next section).**

Rewetting/Desensitization

* Probably the best way to desensitize the tooth when using an “etch and rinse” (total-etch) adhesive system is to use Gluma Desensitizer, or one of the new Gluma-like materials as a rewetting agent. As seen in Fig. 2 below, the Gluma is placed after acid etching, but before placing the resin primer. The Gluma disinfects, seals the dentinal tubules, and also enhances bond strengths, because it is a very effective cross-linking agent. It also has been reported to **reduce MMP activity** (Sabatini et al. 2014 *Dent Mater.*30:752-758). Gluma Desensitizer is particularly effective as a rewetting agent, and results in profound concomitant desensitization. G5 by Clinician's Choice, Calmit by Caulk or Microprime G from Danville are excellent, inexpensive Gluma substitutes for re-wetting that also afford great desensitization.

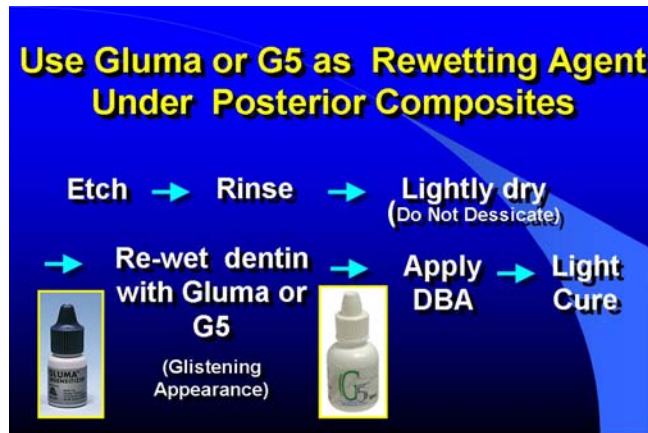


Figure 2

Bonding Systems

*Currently, four basic types of dentinal adhesives exist: Two total-etch (multi-bottle systems & one-bottle) and two self-etch systems (two-step and all-in-ones). The steps involved in each system are seen below in Figure 3.

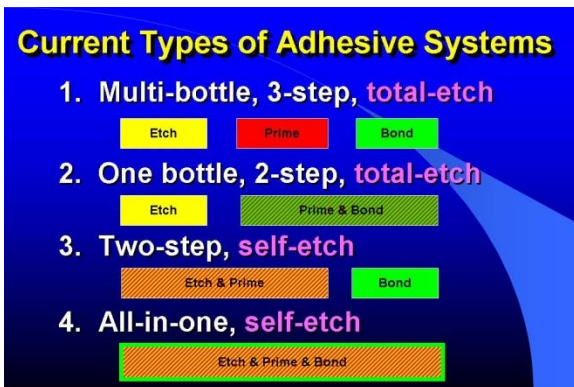


Figure 3



Figure 4

Multi-Bottle Systems

* Classic multi-bottle adhesive systems such as All Bond 2 (BISCO), OptiBond FL (Kerr), and Scotchbond MP Plus (3M ESPE), are still the **“gold standards”** in adhesive dentistry (Figure 4). Their clinical performance has been validated with clinical trials that reveal superior results when compared to virtually all subsequent adhesive systems. Newer versions of some of these materials have since been re-introduced, some in undosed versions. Many are also now radiopaque.

Self Etching Primers

* Self-etching primers simultaneously condition (etch) and prime the dentin (and enamel?), and are the predominantly used adhesive systems used today.

* Two primary types of self-etching primers exist:

-Two-step, self-etch adhesives, where an acidic self-etch primer is used instead of phosphoric acid to etch the enamel and dentin, followed by the application of the adhesive.

-One-step "all-in-one" adhesives where etching, priming and bonding occur simultaneously through application of the self-etch primer. Most current SE materials fall into this category.

Historical examples of two-step self-etch materials include Clearfil SE Bond (Kuraray), Tyrian (Bisco), Adhese SE (Vivadent). Examples of "all-in-one" self-etching primers have included Adper Prompt L-Pop (3M-ESPE), Xeno IV (Caulk), i-Bond (Heraeus Kulzer), S3 Bond (Kuraray) and Optibond All-in-One (Kerr). (See Figures 6-A & B). Clearfil SE Bond has demonstrated particularly good performance in clinical trials, in part due to the incorporation of MDP monomer that enhances adhesion.



Figure 6-A



Figure 6-B

Advantages of Self-Etching Primers:

- Simple to use. Don't underestimate this quality. These are virtually "idiot proof."
- Eliminates variables associated with "wet bonding" (eg. how wet is wet?)
- Depth of etch is self-limiting.
- Sensitivity is reduced, even with incomplete coverage (smear plugs still intact in areas not covered).

Disadvantages of Self-Etching Primers:

- Bond strengths to enamel are typically lower than for total-etch adhesives.
- Bond strengths to self-cured composites are poor for most (Swift, et al. *J Prosthodont* 1998; 7:256-260 and Sanares et al. *Dent Mater* 2001; 17:542-556).
- Clinical performance quite variable; bond durability questionable, especially for all-in-one types (hydrolysis?).

NOTE: The most important bond for clinical success is the enamel bond; problem is most self-etch materials do not offer great enamel bonds, especially to uncut enamel. If you elect to use a self-etch material, a "selective etch" of enamel with phosphoric acid is not a bad idea. However, total-etch systems used with a Gluma-type desensitizer are still best.

New “Universal” Adhesive Systems

New SE systems have been introduced, but as noted in an excellent study by Pashley’s group (Chen et al, J Dent, 2015), with regards to bonds to dentin, they are likely “old wine in new bottles” (Fig. 7) Granted additives like **MDP monomer** and silane afford some a broader range of substrates to which they can bond including zirconia and porcelain. However, **the biggest difference is that these new Universal adhesives are being recommended for use with “selective etch” or “total etch,” which will immediately result in better bonds to enamel and improved clinical performance long-term.** This attitudinal change by manufacturers is welcomed and overdue!



Fig. 7

3M ESPE’s Universal Bond, Caulk’s Prime & Bond Elect, and Bisco’s All-Bond Universal are examples of current “universal” adhesives But as with all new materials, ample clinical validation is ultimately needed.

Even though “universal” adhesives can be used as self-etch adhesives, it is recommended that whenever enamel margins are present, a **selective-etch of enamel or a total-etch approach be used**, since bonds to enamel are essential to clinical success.

Compatibility with Self-Cured Composites

* As noted above for self-etching adhesives, categorically light-cured adhesives of any type that are inherently acidic are not very compatible with self-cured composites (Swift, et al. *J Prosthodont* 1998; 7:256-260 and Sanares et al. *Dent Mater* 2001; 17:542-556). For that reason, some adhesives offer dual-cured versions that consist of the adhesive and a self-cure activator that affords the resulting adhesive some compatibility with self-cured composites (core materials, etc.). Historically multi-bottle etch and rinse systems (total etch) have been known to be compatible with both light and self-cured resins, since the final adhesive component is effectively neutral in pH, and therefore will not interfere with bonding. The same is true for Kerr’s new OptiBond XTR, which is a “throw back” to the old multi-bottle systems in many ways.

Stress Breaking Liners/Tooth Flexure

- * Stress breaking liners are filled bonding agents or GIC liners that provide a thicker adhesive layer that can help resist polymerization or flexural stresses.
- * Examples of stress breaking liners include: OptiBond FL (Kerr), Vitrebond Plus (3M ESPE), and Fuji Lining Cement (GC).
- * Do teeth really flex? Yes, numerous studies have documented that teeth flex under centric and eccentric loading. For the restoration of Class V lesions, a material with a lower elastic modulus (eg. microfilled resins) that allows for better flexural qualities may perform better long-term in patients that exhibit evidence of stressful occlusion or parafunction. Elastic materials may better accommodate tooth biodynamics.
- * Based on clinical trials, it is clear that Class V retention failures are highest among patients exhibiting stressful occlusion (wear facets, history of bruxism, etc.) or who have highly sclerotic root surfaces.
- * In “high risk” patients, Class V preparations should include additional retention form from placement of a gingival retention groove prepared with a No. ¼ round bur.

Lower durability when bonding to dentin compared with enamel:

- * Despite improvements in dentin bonding agents, bonding to enamel is still far more predictable and durable long-term. When given the option (veneer preps, for example), always opt for preparations in enamel.

Meiers JC and Young D. Two-year composite/dentin durability. *Amer J Dent* 2001; 14(3): 141-144.

Hashimoto et al. Resin-tooth interfaces after long-term function. *Amer J Dent* 2001;14(4):211-215.

Okuda et al. Long-term durability of resin dentin interfaces. *Oper Dent* 2002; 27:289-296.

Less predictable when bonding to caries affected or sclerotic dentin:

Nakajima, et al. Bond strengths of single-bottle dentin adhesives to caries-affected dentin. *Oper Dent* 2001; 25:2-10.

Nakajima, et al. Bonding to caries affected dentin using self-etching primers. *Am J Dent* 1999; 12:309-314.