Handout
Adhesive Dentistry
By
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Dentin Bonding

* Regardless of the type dentinal adhesive used, the primary mechanism for 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).

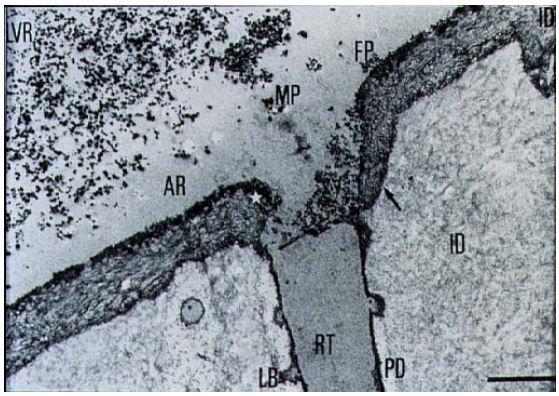

Figure 1

* For traditional dentin bonding techniques (etch-prime-bond) that require "wet bonding," the dentin must not be dehydrated at the time of primer application, or bond strengths will be compromised.

Rewetting/Desensitization

* Probably the best way to desensitize the tooth when using a total-etch adhesive 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. Gluma Desensitizer is particularly effective as a rewetting agent according to research reports (Li et al. JDR 2000; 79:509, Abstr # 2928), and results in profound concomitant desensitization. G5 by Clinician's Choice or Microprime G from Danville are great, inexpensive Gluma substitutes for re-wetting that also afford great desensitization.

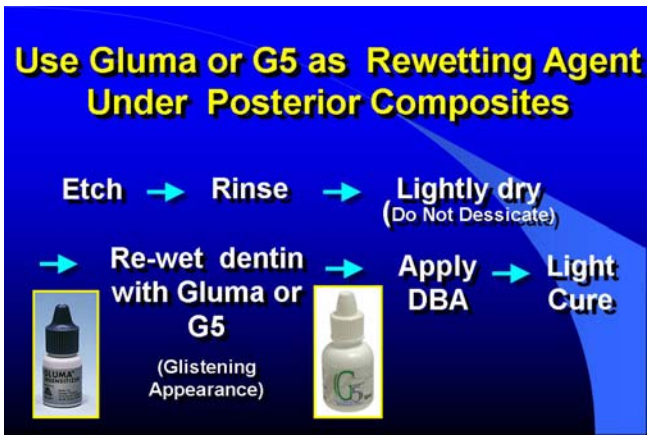

Figure 2

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.

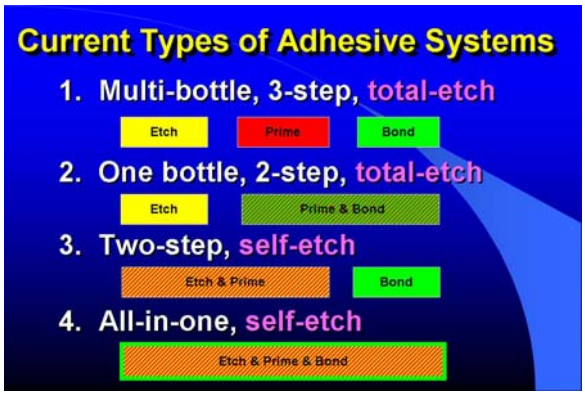

Figure 3

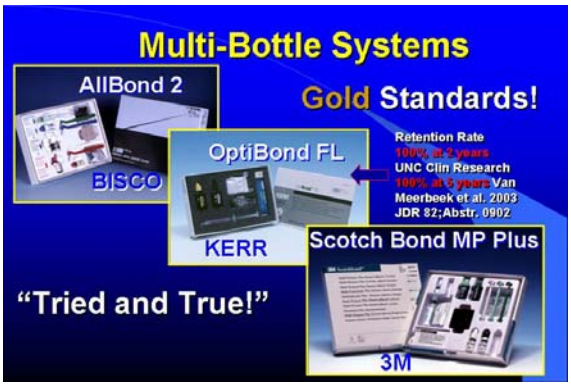

Figure 4

Multi-Bottle Systems

* Classic multi-bottle adhesive systems such as and 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 unidosed versions. Many are also now radiopaque.

One Bottle Systems/Primer Types

* Two primary primer types are used in DBA's today: ethanol and acetone.

* Examples of ethanol-based one bottle DBAs include Adper Single Bond (3M ESPE), OptiBond Solo Plus (Kerr), and Excite (Vivadent). See Figure 5-A..

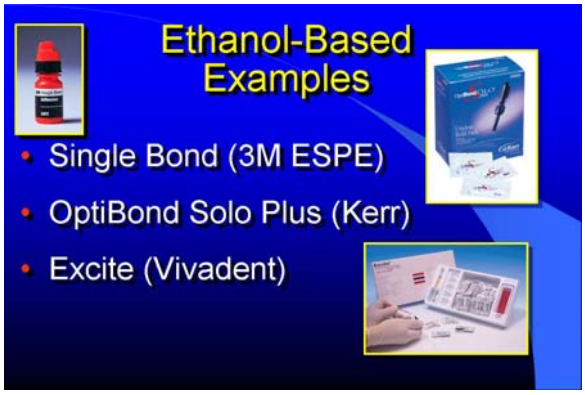

Figure 5-A

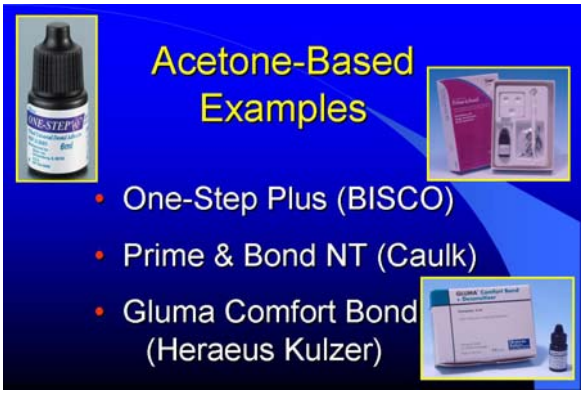

Figure 5-B

* Examples of acetone-based one bottle DBAs include One Step Plus (Bisco), Prime and Bond NT (Caulk), and Gluma Comfort Bond (Heraeus Kulzer). See Figure 5-B.

* For most one-bottle systems, the bond strengths are not a high as for their multi-bottle precursor. However, the differences are not thought to be clinically significant for most products.

* According to a CRA Report from 1997, most one bottle systems were NOT faster in application times when compared to the multi-bottle material, Scotchbond MP.

Self Etching Primers

* Self-etching primers simultaneously condition (etch) and prime the dentin (and enamel?).

* 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.

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 include Adper Prompt L-Pop (3M-ESPE), Xeno IV (Caulk), i-Bond (Heraeus Kulzer), S3 Bond (Kuraray) and Optibond All-in-One (Kerr). Most other manufacturers are following suit with their own versions. (See Figures 6-A & B).

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? Etc.)
- 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.

- Some materials do not adequately etch uncut enamel.
- Bond strengths to auto-curing composites are poor (Swift, et al. *J Prosthodont* 1998; 7:256-260 and Sanares et al. *Dent Mater* 2001; 17:542-556) with exception of Tyrian (BISCO).
- Clinical performance not yet time proven; bond durability questionable, especially for all-in-one types (hydrolysis?).

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, many 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.). BISCO's One Step Plus is one of the notable exceptions to this rule, since it is neutral in pH and is compatible with both light and self-cured resin materials.

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 Solo Plus (Kerr), Clearfil Liner Bond 2V (Kuraray), Vitrebond Plus (3M ESPE), and Fuji Bond LC (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.

* Flowable composites have favorable elastic qualities and the ability to “wet” tooth surfaces well. They, too, can be used as very effective stress breaking liners. However, if using flowable composites under packable posterior composites, KEEP THEM THIN (less than 0.5 mm thickness). Flowable composites exhibit as much as 2-3x the polymerization shrinkage of hybrids, higher CTE’s, and higher water sorption than hybrid composites.

Radiopacity of flowables

* If using a flowable composite under a posterior composite, make sure the brand of material you are using is sufficiently radiopaque (Figure 7)! This is especially true if the flowable is going to be placed along gingival margin areas of proximal boxes. Detection of recurrent caries is difficult is the restorative material is not adequately radiopaque.

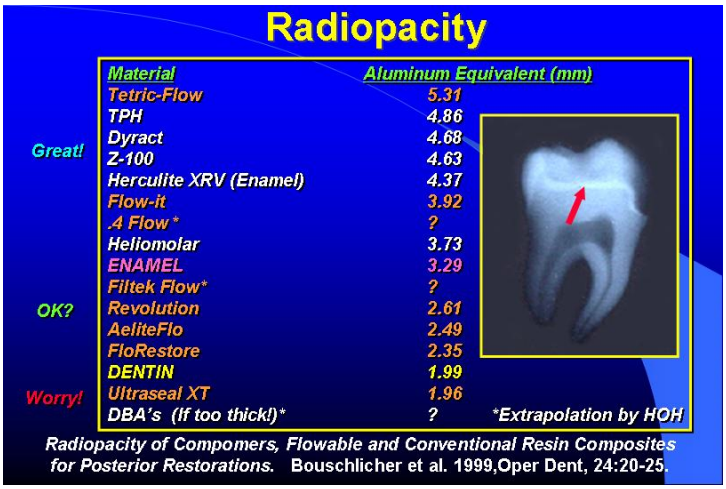

Figure 7

* 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.

Evidence:

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.

Great Sources for Objective, Unbiased Dental Information:

Dental Evaluation and Consultation Service or CES (formerly the USAF Dental Investigation Service)

See website: **https://decs.nhgl.med.navy.mil/**

Journal of Esthetic and Restorative Dentistry
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Dr. Heymann has no financial interest in any of the companies whose products are mentioned in this handout, but is a past consultant for Procter and Gamble and Colgate, and is an unpaid consultant for Clinician's Choice Dental Co. and his son is an employee of Sybron Kerr. Dr. Heymann is the paid Editor-in-Chief of the *Journal of Esthetic and Restorative Dentistry* noted above.