2016 *CDA Presents* in Anaheim

Clinical Keys for Adhesive and Restorative Success - 2016

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Saturday, May 14, 2016
8–10:30 a.m.

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Handout
Adhesive Dentistry/Posterior Composites
Harald O. Heymann, DDS MEd

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).

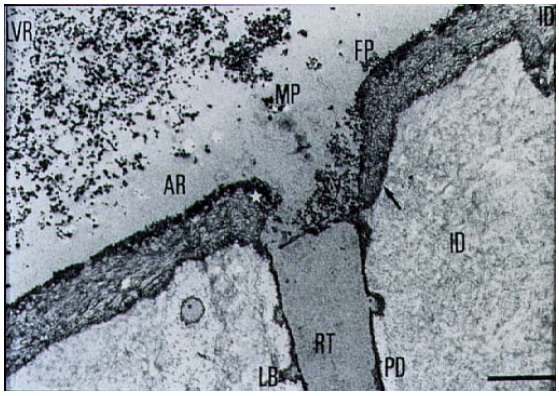

Figure 1

* For traditional dentin bonding techniques (etch and rinse systems) that require "wet bonding," the dentin must <u>not</u> 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 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.

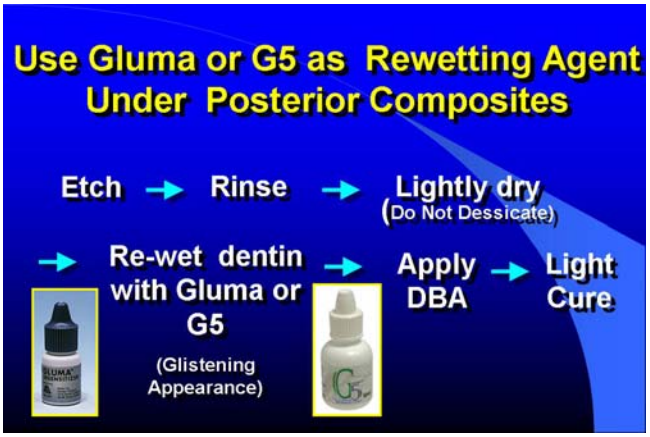

Figure 2

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.

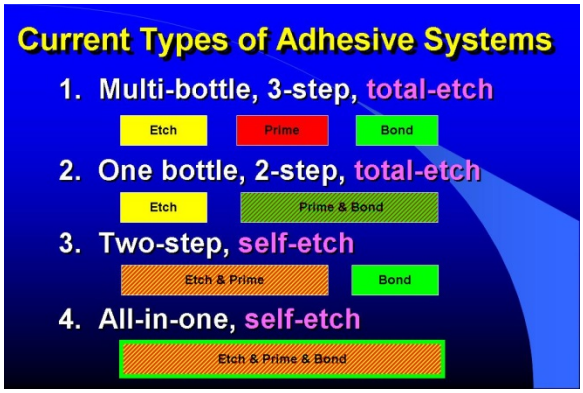

Figure 3

Figure 4

Multi-Bottle Systems

* Classic multi-bottle adhesive systems such as 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.

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

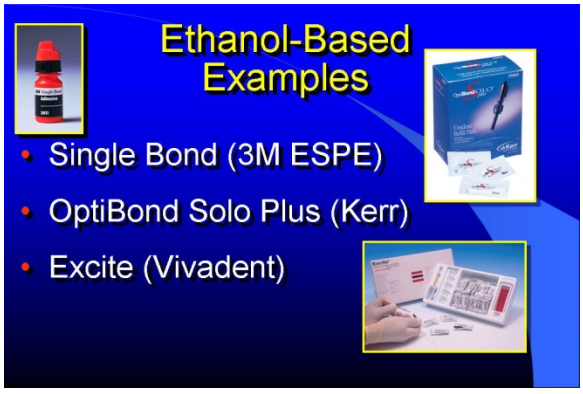

Figure 5-A

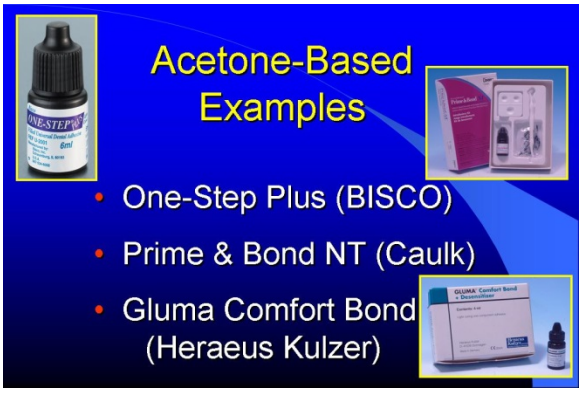

Figure 5-B

* Historical 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.

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 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!

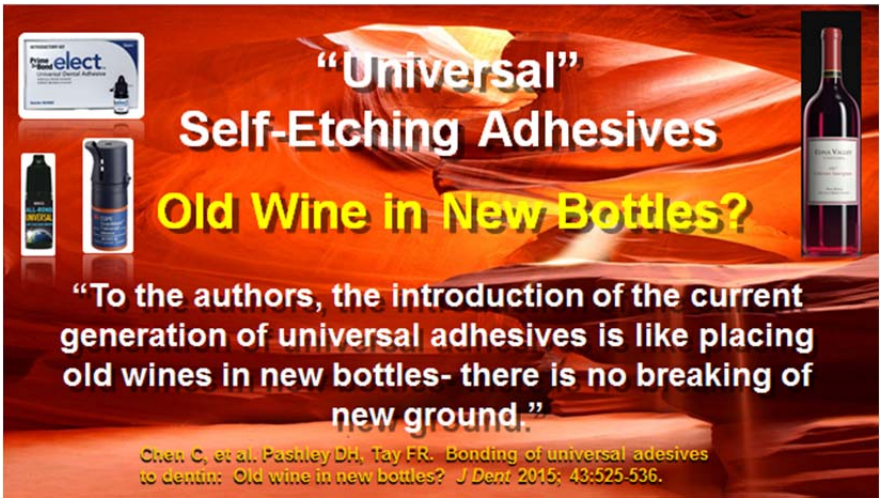

Fig. 7

3M ESPE's Universal Bond, Caulk's Prime & Bond Elect, and Bisco's All-Bond Universal are examples of current "universal" adhesives. Additionally, a unique multi-bottle system, OptiBond XTR (Kerr) which contains BPDM has shown high bond strengths to enamel and excellent performance in clinical trials to date (Swift et al., 2011, Ritter et al, JDR, 2015). 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), <u>always opt for preparations in enamel</u>.

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.

****Handout****
By Harald O. Heymann, DDS, MEd

Keys to Success with Posterior Composites

<u>What are the Most Frequent Causes of Posterior Composite Failure?</u>

- **Poor isolation.** A rubber dam is always preferred, but in maxillary arch, sometimes other options are OK.
- **Poor adaptation.** Limited application of a flowable composite along the proximal marginal interfaces can improve marginal adaptation, especially when using thicker, more thixo-tropic "packable" posterior composites.
- **Undercuring of composite, particularly along gingival margins.** By the "Law of Squares," (Inverse Square Law), as you increase the distance of the curing light from the composite increment, the intensity of the light diminishes significantly, thereby reducing the efficacy of the cure. Use at least 10s per 2mm of composite with today's LED lights.
- **Polymerization shrinkage effects**. Volumetric shrinkage of resin composites can result in bond disruption, cuspal flexure and marginal damage if not controlled.
-

The "Fluoride Myth"

Fluoride is incorporated into everything from bonding agents to cements to many types of restoratives. However, anticariogenic effects are largely limited to only two categories of restorative materials: resin modified glass ionomers and glass ionomers (Figure 1).

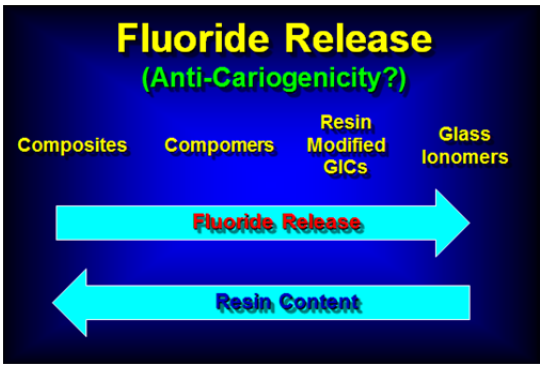

Figure 1

Because RMGICs and GICs experience an acid/base reaction, they are capable of being "recharged" with fluoride upon exposure to subsequent sources of fluoride (eg. dentifrice, varnish, rinses, etc.). According to Donaly et al., a "zone of caries inhibition" can result in tooth structure immediately adjacent to RMGIC and GIC restorations.

Polymerization Shrinkage Effects

Excessive composite shrinkage resulting from bulk filling in high "at risk" (high C-Factor) preps, such as Class Is, can result in bond disruption. Clinically gap formation of this type can result in pain upon biting, due to compression of a fluid filled gap. Marginal damage resulting from traumatic finishing also is a risk when polymerization shrinkage is high. Abrasive instruments and spiral cut finishing burs can reduce marginal trauma and "white line" formation.

What Can be Done to Deal with Adverse Effects from Polymerization Shrinkage?

- Place a stress breaking liner (eg. Vitrebond by 3M ESPE).
- Use incremental additions, especially in Class I preps.
- Do not bulk fill, especially in Class I preps.
- Use "soft start" polymerization (eg. distance curing or "poor man's ramped cure") for curing the first increment along the pulpal floor.

Light Curing

Blue LED lights represent significant advantages over past quartz halogen and PAC light systems. Most are compact, rechargeable, cooler, quieter, exhibit almost unlimited bulb life and are highly efficient. Many excellent blue LED lights exist including the Elipar S-10 by 3M ESPE, the Valo by Ultradent, the Bluephase 20i by Ivoclar and many others. The Demi Ultra by Kerr also is a very intriguing choice in LED lights owing to its ultracapacitor power source, meaning it uses no batteries. Pay your money and take your choice!

Bulk-Fill Flowable Bases

Bulk-Fill flowable composite bases (eg. Surefil SDR by Caulk Dentsply) have a greater depth of cure due to a greater amount of photoinitiator, and they resist the effects of polymerization shrinkage owing to their favorable elastic modulus. However, DO NOT place bulk-fill flowables of this type in contact areas or areas subject to occlusal stress because of their relative lack of resistance to wear.

How Can You Improve Flow of Posterior Composites and Thereby Reduce Voids and Improve Adaptation?

Heating of Composite- Since composites are thermoplastic, heating them can facilitate their ability to flow. A technique developed by Drs. Tom Hilton and Jack Ferracane, University of Oregon, uses 11 gauge needle tubes (Centrix) filled with composite (Figure 2) and heated in a Calset Composite Warmer (Addent) to facilitate flow and insertion of the posterior composite material (Figure 3).

Figure 2

Figure 3

Vibration of Composite- A very innovative concept that utilizes vibration of composite to facilitate insertion is seen in the new SonicFill II system by Kerr (Figure 4). Composite contained in unit dose tips is rendered to a flowable consistency through vibration from a sonic handpiece, improving adaptation of the composite to the cavity walls. Flow of the composite is increased by 87% through the incorporation of rheological modifiers, and depth of cure is enhanced through the use of a greater amount of photoinitiators.

Figure 4

Matrixing Systems

Matrices for MODs- Convexi-Ts by Clinician's Choice are very thin, pre-contoured stainless steel matrix bands that are held in a Tofflemire type retainer. This is an excellent choice for MOD posterior composite restorations.

Matrices for two-surface preps- Sectional matrices secured with a bitine ring represent a superb choice for the restoration of two-surface posterior composites. The V3 or V4 sectional matrix systems by Triodent include pre-contoured matrix bands as well as an innovatively designed bitine ring with forked tines that facilitate "straddling" the wedge for a more secure fit. An equally effective and similar system is the Palodent Plus system by Caulk Dentsply, as well as the Composi Tight 3D system from Garrison.

Important Clinical Tip

The most important step in establishing consistently tight proximal contacts with posterior composites is "pre-wedging." This concept involves the placement of a wooden wedge immediately following administration of the anesthetic into the proximal area to be restored prior to initiation of the tooth preparation and replacement with a new wedge at the time of matrix placement. This approach allows for ample time to attain the needed orthodontic movement of the involved teeth in order to compensate for the thickness of the metal matrix band. It works!

Speaker Information

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Dr. Heymann has no financial interest in any of the companies whose products are mentioned in this handout, but has been a scientific advisor for Clinical Research Dental Co.
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