

Ask the Experts

DENTIN/ENAMEL BONDING

Associate Editor Edward J. Swift, Jr., DMD, MS*

QUESTION: Several different types of dentin/enamel adhesives are available and I am confused about which one(s) to use in my practice. Can you rate the various categories of resin-based adhesives for me?

ANSWER: Dentists have been able to bond to enamel with great reliability and predictability for many years. Dentin is a far more complex and variable substrate than enamel and a more difficult one for resin bonding. However, we have been able to bond resins to dentin with good clinical success for the last couple of decades. Over that time, four "generations" of adhesives have appeared on the market. The availability of these different generations and the numerous products within each make for a very confusing situation for the dentist trying to select specific products for use in the practice.

Personally, I do not care for the "generations" classification of the

resin-based adhesives. When you consider materials that are no longer available, we have had several generations of adhesives, and this classification scheme can confuse more than clarify the available options. As an alternative, I prefer to classify the available products by their bonding mechanism and application steps.

Two major strategies exist for resin bonding—etch-and-rinse (originally called "total-etch") and self-etch. For each strategy, specific materials use either a somewhat complex or a somewhat simplified approach. Thus, four distinct categories of *current options* can be identified.

The first category of current options is the oldest, and the materials in this category are *three-step*, *etch-and-rinse adhesives*. Examples include Adper Scotchbond Multi-Purpose (3M ESPE, St. Paul, MN, USA), All-Bond 2 and 3 (BISCO, Schaumburg, IL, USA) OptiBond FL (Kerr, Orange, CA, USA), and PermaQuick (Ultradent, South Jordan, UT, USA).

These systems use phosphoric acid to etch both enamel and dentin. Etching is followed by a priming step that alters the surface free energy of the dentin, beginning resin impregnation of the surface and making it receptive to wetting and further impregnation by the third step, a fluid resin bonding agent. The result of these successive steps is formation of a resindentin hybrid layer, or a physical mixture of dentin and resin linking the two together.

The three-step etch-and-rinse adhesives have provided excellent clinical service. In the laboratory, their bond strengths and bond durability to both enamel and dentin are excellent. They are versatile materials that can be used with any type of composite material, whether light- or self-activated.

*Professor and Chair, Department of Operative Dentistry, University of North Carolina, Chapel Hill, NC, USA

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The second category of current options is the *one-bottle etchand-rinse adhesives*. The term "one-bottle" is something of a misnomer, as these systems include a phosphoric acid-etching step. They are described as one-bottle systems because they deliver the primer and bonding agent steps in a single solution. This is the same simplified approach seen in some consumer products, such as combination shampoo and conditioners, or the new combinations of primer and latex paint.

Examples of the one-bottle systems include Adper Single Bond Plus (3M ESPE), MPa Direct (Clinician's Choice, New Milford, CT, USA), One-Step Plus (BISCO), OptiBond Solo Plus (Kerr), and Prime & Bond NT and XP Bond (Dentsply Caulk, Milford, DE, USA).

Like their three-step predecessors, these materials provide an excellent bond to enamel. Their initial bonds to dentin can approach those of the three-step materials, but their durability in laboratory storage conditions and their performance in controlled clinical trials have not been as good. Their adhesion to dentin is most durable when the dentin is protected by a rim of etched and bonded enamel.

Although these materials are somewhat easier to use than the threestep adhesives, their popularity has suffered from reports of postoperative sensitivity. At least for some products, the postoperative sensitivity might be related to failure to maintain a proper level of surface moisture after etching and rinsing. Also, many products in this category cannot be used with self-cure composites.

The third category of resin-based adhesives is the two-step self-etch materials, or the *self-etching* primer systems. Examples include Adper Scotchbond SE (3M ESPE), Clearfil SE Bond (Kuraray, Tokyo, Japan), and Peak SE (Ultradent). The first step in these systems is a primer containing acidic monomers that simultaneously etch and prime the tooth surface. The acidity of these primers is generally mild. This is an advantage for dentin bonding, as theoretically it would result in less postoperative sensitivity. A decreased incidence of postoperative sensitivity has been widely reported anecdotally, but has not been validated by clinical trials.

The mild nature of these primers also allows for formation of some chemical bonding to residual hydroxyapatite, which can improve the durability of resin-dentin bonds. One clinical study reported excellent clinical performance for Clearfil SE Bond at 5 years. A disadvantage of the mild acidity is reduced efficacy of enamel etching, particularly when the enamel has not been instrumented in any way. For example, if a selfetch system is used and resin is extended beyond an instrumented margin, marginal staining is likely to occur.

The final category of adhesives is the self-etch adhesives, or *all-inone adhesives*. As their name implies, these deliver all three functions—etching, priming, and bonding—simultaneously. Specific products vary, with some supplying these three functions in a single premixed solution while others require mixing just prior to application.

As a group, these all-in-one adhesives have the least proven clinical performance. The earliest products in the category had poor enamel or dentin bond strengths or both. However, the newer products are improving, at least in regard to the initial bond strengths measured in the laboratory. For example, in recent testing, we have obtained good in vitro bond strengths with such products as Bond Force (Tokuyama, Osaka, Japan) and OptiBond All-in-One (Kerr).

My biggest concern about the allin-one adhesives is their potential lack of clinical longevity. They are very hydrophilic in nature, and this could result in more rapid degradation in the oral environment. Some laboratory studies have shown that these materials work better when they are coated with a more hydrophobic resin. However, this additional step basically converts them into self-etching primers, thus eliminating their main benefit, the ability to do "everything" at once.

Returning to the original question: how do you rank these categories of adhesives? Certainly, the threestep etch-and-rinse adhesives are the most well proven, the most durable for both enamel and dentin, and the most versatile option. At the other extreme, the all-in-one adhesives are the least well proven and quite likely the least durable.

The relative quality of the two "middle" categories might be viewed differently by different experts. The one-bottle etch-andrinse adhesives bond extremely well to enamel and very well to dentin when it is protected by etched enamel. They can, however, suffer from undesirable postoperative sensitivity when not used correctly.

In contrast, the self-etching primer systems seem to have very little postoperative sensitivity, perhaps with little operator influence. However, their enamel bond is less than that of the etch-and-rinse systems. This is an important consideration because the bond of resin to properly etched enamel is the best and most durable bond that we can obtain in adhesive dentistry.

In conclusion, several options are available for bonding resin-based materials to dentin and enamel. With the relative advantages and

Editor's Note: If you have a question on any aspect of esthetic dentistry, please direct it to the Associate Editor, Dr. Edward J. Swift, Jr. We will forward questions to appropriate experts and print the answers in this regular feature.

Ask the Experts Dr. Edward J. Swift, Jr. Department of Operative Dentistry University of North Carolina CB#7450, Brauer Hall Chapel Hill, NC 27599-7450 Telephone: 919-966-2770; Fax: 919-966-5660 E-mail: ed_swift@dentistry.unc.edu disadvantages of each in mind, clinicians must decide for themselves which adhesive(s) are most appropriate for use in the practice.

Editor's note: This same topic will be addressed by other experts in subsequent issues of the *Journal* this year.

SUGGESTED READING

- DeMunck J, Van Meerbeek B, Yoshida Y, et al. Four-year water degradation of totaletch adhesives bonded to dentin. J Dent Res 2003;82:136–40.
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- Wilder AD, Swift EJ, Heymann HO, et al. 12-year clinical evaluation of a three-step dentin adhesive in non-carious cervical lesions. J Am Dent Assoc 2009;140:526– 35.

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