

Adhesives

There is so much information available on adhesives that you can “prove“ almost anything. For example, in one study with eight self-etching adhesives, iBond was the only product which was equivalent to the control etch-and-rinse system in enamel. (Owens BM. Oper Dent 2006;23:60-7) However, iBond has done very poorly in other studies, including clinical trials.

- Perdigao J, et.al. Two year clinical evaluation of self-etching adhesives in posterior restorations. J Adhes Dent 2009;11:149-59

Manufacturers contribute to the confusion with constant introduction of “new” products. Dentists seem particularly vulnerable to the argument of simplicity, even when quality is compromised.

Self-etch vs. Etch-and-Rinse in Enamel

There is overwhelming proof that the traditional acid etching of enamel provides both a better bond and less clinical marginal staining than any available self-etching product.

- Cehreil ZC and Gungor HC. Quantitative microleakage evaluation of fissure sealants applied with or without a bonding agent: results after four-year water storage in vitro. J Adhes Dent 2008;10:379-84
- Perdigao J, et.al. Enamel bond strengths of pairs of adhesives from the same manufacturer. Oper Dent 2005;30:492-9
- Frankenberger R and Tay RF. Self-etch vs. etch-and-rinse adhesives: effect of thermo-mechanical fatigue loading on marginal quality of bonded resin composite restorations. Dent Mat 2005;21:397-412

Bond Stability

Bond stability on dentin is a problem, particularly with single component bonding agents. Note that the number of components is more important than the difference between self-etch and etch-and-rinse.

- Garcia RN, et.al. Effect of water storage on bond strength of self-etching adhesives to dentin. Journal of Contemporary Dental Prac 2007;8:1-11
- De Munck, et.al. A critical review of the durability of adhesion to tooth tissue; method and results. J Dent Res 2005;84:118-32
- Donmez N, et.al. Ultrastructural correlates of in vivo/in vitro bond degradation in self-etch adhesives. J Dent Res 2005;84:355-9

There is considerable research being done at the present time using collagen crosslinkers or enzyme inhibitors as components of dentin bonding agents, or the use of antibacterial agents such as 2% chlorhexidine prior to adhesive application. Syntac (developed in the 1980's) contains glutaraldehyde, an antibacterial collagen crosslinker.

The very significant differences seen in laboratory investigations are indeed reflected in clinical results, although differences in annual failure rates of Class 5 restorations (loss of retention) are relatively small (if you consider a 3%.higher failure rate per year “small”).

- Peumans M, et.al. Clinical effectiveness of contemporary adhesives; a systematic review of current clinical trials. Dent Mat 2005;21:864-81

The best adhesives are the selective or total etch products of the third and fourth generations, developed in the time period around 1990, followed by the 2-component self-etch materials (provided you accept staining at enamel margins as success).

With self-etching single component materials, chemical reactions in the bottle are a major problem. The manufacturers should be able to prove that their monomers are hydrolytically stable.

- Moszner N, Salz U, Zimmermann J. Chemical aspects of self-etching enamel-dentin adhesives: a systematic review. *Dent Materials* 2005 ;21:895-910

There is no “magic” bond strength which will prevent gaps. Any lecturer making this type of statement is an idiot. (The original claim of 17 MPa with a shear test was an extrapolation.) Shear bond strength values correlate with nothing: not with gaps, and definitely not with clinical results.

- Kusonoki M, et.al. Contraction gap vs. shear bond strength of dentin adhesive in sound and sclerotic dentin. *Dent Mat Journal* 2006;25:578-83
- Van Noort R, et.al. The effect of local interfacial geometry on the measurements of the tensile bond strength to dentin. *J Dent Res* 1991;70:889-93
- Al-Saleh SK and Burke FJT. Methods used in dentin bonding tests; an analysis of 50 investigations on bond strength. *Quintessence Int* 1997;28:717-23
- Van Noort R, Noroozi S, Howard IC, Cardew G. A critique of bond strength measurements. *J Dent* 1989;17:61–67

Although we have known this for many years, researchers continue to use a completely irrelevant test method so that they can compare their new useless numbers with their old ones.

Solvents

The solvents present in the first component are very important for the application technique, although in my experience many dentists are not sure which solvent is contained in the adhesive they are using, and the manufacturers often do not even mention it. Basically, there are three solvents used in dental adhesives: acetone, ethanol, and water. (The addition of water to acetone or ethanol does not change the application technique.)

- Perdigao J and Frankenberger R. Effect of rewetting time and solvent on adhesion to dentin. *Quintessence Int* 2001;32:385-90

Acetone

Acetone fixes collagen. If the collagen has been exposed by etching and then acetone is applied, infiltration is prevented. Acetone has a very high vapour pressure and helps by chemically evaporating the water. Acetone based products **MUST** be applied to wet dentin, too wet is better than too dry. Each application removes more water, they therefore work best when applied several times (without air drying between applications).

Ethanol

Many lecturers have claimed that ethanol-based materials are less technique sensitive, which is not really true. The ideal situation is “damp”, however we want to define the term damp. They do not work well on etched and dried dentin, although not as catastrophically bad as acetone-based materials. On wet dentin, ethanol is not as efficient in removing water as acetone: in this case several applications also help, but they need to be dried after each application. Yes, you can always make them work. No, I do not find them sensible.

Water

Placing a water-based material on wet dentin makes no sense, the dentin should be dried but not desiccated. (Even then, they will work if given more contact time to rehydrate the

collagen, but the rule of thumb is that ten seconds of additional drying after visible water is removed requires 60 seconds of additional contact time!)

ALL self-etching adhesives use water as their solvent, because the water is required to hydrolyse the acidic groups. Water-based materials should be dried slowly to avoid blowing away all the resin, but thoroughly to remove the water, the drying times recommended by manufacturers are ridiculous.

All solvents must be removed after application. Acetone evaporates so quickly that only very brief drying is required. The dentin quickly becomes matt, sometimes with a slight sheen. Ethanol requires a longer drying time, a good rule of thumb is that there should be no movement of the adhesive layer under the air stream. Water based materials should be dried until the dentin looks dry, about five to ten seconds for a Class 5, considerably longer in more complex cavities.

Single Component Adhesives

Single component adhesives (self-etch or etch-and-rinse) work better if applied at least twice, but they work even better if applied once and then followed by a hydrophobic solvent-free resin. Since any theoretical time savings is eliminated, I fail to understand why anyone would use a single component adhesive.

- D'Arcangelo C, et.al. The influence of adhesive thickness on the microtensile bond strength of three adhesive systems. *J Adhes Dent* 2009;11:109-15

If used according to the instructions for use, they are associated with a lack of bond stability, increased postoperative sensitivity, and increased failure rates due to loss of retention or stained margins. Thick layers of adhesive also can ruin the aesthetics and make radiographic diagnosis at later controls difficult or impossible.

Summary

Enamel should be etched with phosphoric acid. (At least for permanent teeth, we could argue about primary teeth.)

Self-etching adhesives work extremely well on dentin, and reduce the technique sensitivity associated with residual moisture content after "etch-and-rinse". In deeper dentin, there is less postoperative sensitivity with self-etching adhesives. In shallow cavities, there is no difference between self-etch and etch-and-rinse.

- Unemori M, et.al. Composite resin restoration and postoperative sensitivity: clinical follow-up in an undergraduate program. *Am J Dent* 2001;29:7-13

One thing should be made very clear: which adhesive you use lies far behind the importance of diagnosis and restorative technique selection, or preparation technique for that matter.

Recommendations

When enamel can be selectively etched, a self-etching 2-component dentin adhesive could be seen as "state-of-the-art" at the present time.

- Frankenberger R, et.al. Selective enamel etching reconsidered: better than etch-and-rinse and self-etch? *J Adhes Dent* 2008;10:339-44
- Rotta M, et.al. Effects of phosphoric acid pretreatment and substitution of bonding resin on bonding effectiveness of self-etching systems to enamel. *J Adhes Dent* 2008;9:537-45

Naturally, there are clinical situations when it is nearly impossible to “selectively” etch enamel, generally with minimally invasive preparations. Since here we are basically never dealing with deep dentin, a two component “etch-and-rinse” adhesive is the best choice.

In deep dentin, conventional glass ionomer cements such as Ketac-Molar or Fuji IX bond more predictably than any dentin adhesive. I use these in very deep preparations, in particular with younger patients or in cases with a high probability of endodontic treatment due to borderline preoperative symptoms. You can make them set faster with heat, i.e. a high intensity light.

- Augusti D and Paglia G. Shear bond strength of self-etching adhesive systems to deep dentin. *J Dent Res* 2008: Abstr. 386
- Lopes GC, et.al. Dentin bond strengths of simplified adhesives: effect of dentin depth. *Compend Contin Educ Dent* 2006;27:340-5