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A snapshot of dental adhesives

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Dr. Michael Buonocore is often credited with the emergence of modern dental adhesive science.

This was a result of his 1955 work (1) which detailed etching of enamel with acid as well as his later 1968 publication (2) where he described the “prism-like” tags of resin material that were able to penetrate an enamel surface that had been conditioned with phosphoric acid.

Although they vary in application, today’s four types of adhesive systems are predicated upon the same principles that resulted from these seminal studies (e.g., inorganic tooth material is exchanged for synthetic resin).

Three-step etch and rinse

Considered the gold standard for resin-based dental adhesive materials, these products have been available for more than 20 years. They have a long track record of laboratory studies and clinical trials to help support claims that they are a superior adhesive system when compared to other, more recent systems.

The use of this system requires a total etch of the enamel and dentin with phosphoric acid (conditioner).

This initial step removes the smear layer, microscopically roughens the enamel surface and demineralizes the dentinal tubules, essentially preparing the surface for the subsequent adhesive steps.

The second step requires priming (adhesion promotion) the exposed enamel and dentin with hydrophilic resin monomers that are carried in a solvent (acetone, ethanol or water).

This “rewetting” of the surface changes the surface energy of the dentin and allows for infiltration of the collagen fiber network to aid in the establishment of a hybrid layer.

The final step is the application of an aqueous adhesive resin (bonding agent) that creates resin tags that effectively seals the dentinal tubules, provides for micromechanical retention and creates an interface to link to the restorative composite resin.

Examples include Optibond FL (Kerr),

All Bond 2 (Bisco), Scotchbond MP Plus (3M ESPE) and PermaQuick (Ultradent).

Two-step etch and rinse

In order to simplify the adhesive process, a one bottle, two-step etch and rinse approach was developed whereby the priming and bonding steps were combined into one.

Both the three and the two-step method use the same adhesion mechanism and this system still requires the total etch of enamel and dentin with phosphoric acid prior to the application of the primer/adhesive solution.

Examples include Optibond Solo Plus (Kerr), One-Step Plus (Bisco), Adper Single Bond (3M ESPE), Prime & Bond NT (Dentsply), Excite (Vivadent) and PQ1 (Ultradent).

Two-step self-etch

The self-etch adhesives simultaneously condition and prime enamel and dentin. With the two-step self-etch system, an acidic self-etch primer is used instead of phosphoric acid. This step is then followed by the application of the adhesive resin. One of the materials in this category, Clearfil SE, has been extensively studied and has been shown to exhibit a true chemical bond in addition to the mechanical bond that is characteristic of all resin-based systems. These bond strengths are in fact, superior to the two-step etch and rinse category of adhesives. In the self-etch category, this product has become the “gold standard”.

Examples include Clearfil SE (Kuraray), Optibond XTR (Kerr), Adhese SE (Vivadent) and Peak SE (Ultradent).

All-in-one self-etch

Being “all-in-one” means etching, priming and bonding occur simultaneously through the application of the self-etch primer. This category of dental adhesives remains popular due to their simplicity, although both in vitro and in vivo studies have revealed serious shortcomings in their properties.

In particular, they exhibit lower bond

strengths in comparison to multi-step self-etch and etch-and-rinse systems. It also is important to note that two-step and all-in-one self-etching adhesives are poorly compatible with self-cured composites.

Examples include Optibond All-in-One (Kerr), Xeno IV (Dentsply), i-Bond (Heraeus Kulzer) and S3 Bond (Kuraray).



Summary

The three-step etch and rinse adhesive systems have universal application in the fact that they can be used with both direct and indirect restorations and with both self-cure and light cured composite resins. They remain the preferred choice if one were to keep only one system on hand.

A two-step self-etch system should not only be considered as an attractive alternative when compared to the two-step etch and rinse category, but is in fact the preferred system.

References

1. Buonocore M. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *Journal of dental research*. 1955;
2. Buonocore MG, Matsui A, Gwinnett AJ. Penetration of resin dental materials into enamel surfaces with reference to bonding. *Arch. Oral Biol*. 1968 Jan.;13(1):61–70.