***J. Int Oral Health* 2010**


# Self-etch Adhesives: Simple, Easier… but is it Better?

**R Vinaychandra***

*MDS, Reader, Dept of Conservative dentistry and Endodontics, Rajarajeswari dental college and Hospital, Mysore road, Bangalore, Karnataka, India.
Contact: dr.vinaychandra@yahoo.com

**Abstract:**
Current trends in clinical restorative dentistry include an emphasis on self-etching adhesive systems. These systems were introduced in the late 1980s and have been further developed during the ensuing 20 years. This article discusses scientific principles of self-etch adhesive systems, clinical considerations when using these systems, and provides the clinical technique when using a self-etch system.

**Introduction:**
As compared to the earlier total-etch systems, the self-etching systems have enjoyed increased popularity. Total-etch systems use phosphoric acid as a surface conditioner. The acid is applied simultaneously to enamel and dentin prior to application of ambiphillic primers and adhesives, either in separate steps or combined in one bottle. Phosphoric acid demineralizes the hydroxyapatite in enamel, leaving a distinctive honeycomb-etch pattern, and removes the smear layer and demineralizes dentin to varying depths while opening dentinal tubules and exposing organic collagen fibers.[1-3] Failure to support this collagen filigree with a proper level of moisture (ie,wet-bonding) and failure to fill the demineralized zone of the inorganic dentin completely with adhesive can adversely affect the resulting restoration. Excessive drying of the dentin can lead to collagen fibril collapse, which creates a variably impermeable layer that may prevent the diffusion of acrylic monomers into the demineralized layer.[1]

Furthermore, this incomplete diffusion of monomers results in incomplete sealing of the dentinal tubules that were opened during the etching process.[1,3] Open but unsealed dentinal tubules permit dentinal fluid flow during thermal and tactile stresses, which in turn stimulates nerve fibers in the pulpal tissue.

*P- ISSN*
*0976 – 7428*

*E- ISSN*
*0976 – 1799*

***Journal of International Oral Health***

Conservative & Endodontics

Review Article

*Received: May, 2010*
*Accepted: June, 2010*

**Bibliographic listing:**
EBSCO Publishing Database, Index Copernicus, Genamics Journalseek Database

This stimulation is thought to be the primary source of postoperative sensitivity, and the patient experiences it when eating or drinking hot or cold foods or when simply biting on the restored tooth.[4] Postoperative sensitivity of this nature is quite common and a source of patient complaints.The newest adhesive systems are described as self-etching, since they employ the use of acidic monomers of acrylic that etch both enamel and dentin while simultaneously depositing resin into the demineralized zone. The primary advantage of self-etching systems is that they avoid the vulnerable period that occurs after traditional phosphoric acid etchant is rinsed from the tooth but prior to the subsequent application of acrylic monomers. At this time, exposed collagen must be supported by moisture.[5,6] With self-etching systems, the acidic component is not rinsed from the tooth, thus eliminating this vulnerable period of collagen fibril collapse. Another advantage of these systems is that complete permeation of the acrylic monomers to the depth of the demineralized zone is guaranteed.[5] With traditional total-etch systems, it is clinically possible to etch deeper than the subsequent primer/adhesive can penetrate, leaving a zone of unsupported, demineralized dentin that can weaken the adhesive layer and leave it vulnerable to hydrolysis and premature degradation[7] This phenomenon does not occur with self-etch systems, possibly enhancing their stability over time.[7]

**Tooth Preparation: Enamel**

Although all modern self-etching primer/adhesives contain acidic monomers of varying concentration and pH, variability in the depth of resin tag formation in enamel exists.[9-11] Studies have demonstrated that the acidic component of self-etching systems does not create enamel etch patterns on intact enamel seen with traditional phosphoric acid.[12-16] Therefore ,the long-term durability of these bonds in clinical situations remain questionable.[17]

Various pretreatments of enamel surfaces have been suggested for self-etching systems,[18-20] and several manufacturers recommend not applying self-etching adhesives to intact or nonabraded enamel.[21] Intact enamel often demonstrates a low surface energy, aprismatic layer that is not conducive to sufficient mechanical etching by most self-etching systems.[22,23] There is debate concerning how this instrumentation should be completed (air abrasion, use of a diamond bur, etc). Studies have shown that coarse diamond abrasion is sufficient to remove the aprismatic enamel layer and expose the enamel prisms to create micromechanical undercuts.[24,25] This is dependent on the angle of the enamel prisms at the cavosurface margin, and practitioners should be mindful of this angulation when preparing teeth.

Milicich and others have studied typical posterior class I and class II preparations and determined that the use of beveling increases as the cavosurface margin moves closer to the cusp tip. This is based on the inclination of the enamel rods.[26,27] There-fore, when enamel cavosurface margins are within the middle one third of the tooth, simple coarse diamond roughening without a bevel is sufficient. In larger preparations greater than one third of the diameter of the tooth where the enamel cavosurface approaches the terminus of a cuspal incline, deeper bevels are best accomplished by selective, round diamond burs. This type of beveling should be deep enough to permit an appropriate thickness of adhesive and composite, and not so shallow as to leave a thin, friable layer that is prone to chipping[26,27]

In class V preparations, when all margins of the preparation are in a sufficient depth of enamel, a deep, long enamel bevel ranging from 1 to 2 mm should be prepared to permit the acidic component of the self-etching adhesive to come in contact with the abraded ends of enamel prisms rather than the sides of the enamel rods normally exposed with traditional amalgam-type preparations.[29] The exact role of mechanical retention in class V preparations that are restored with self-etching systems is not well defined. It is reasonable to conclude that the use of selective micromechanical grooves and undercuts could have benefit, particularly in class V preparations where occlusal stress may be present and abfraction-type lesions are present.[30-32]

Several technical issues regarding the use of self-etching adhesive systems in class V restorations are addressed in the literature. The common occurrence of sclerotic or hypermineralized dentin, the lack of adequate cervical enamel, poor bond strengths of resin to exposed cementum margins, the role of occlusal stress, and the difficulty in creating and maintaining a dry operating field all support the potential benefit of incorporating mechanical retention into the preparation.[28-36] It is suggested that it is important to gain proper isolation of the defect via a rubber dam or atraumatic subgingival cord retraction. The use of an amalgam-type box preparation, with circumferential undercuts to include a gingival trough that is not prepared at the expense of any remaining cervical enamel, is also advised. For anterior teeth requiring class III or class IV restorations, a long, undulating enamel bevel extending at least 1 to 2 mm or beyond the cavosurface is suggested.[28]

**Tooth Preparation: Dentin**

The type of bur used to prepare dentin may affect the clinical performance of some self-etching adhesive systems. The advantages of using diamond burs to roughen enamel and create bevels in certain situations have been discussed. In contrast, it is important to note that using a diamond bur to roughen healthy, non-sclerotic, non-caries-affected dentin provides no distinct advantage and possibly creates a problem with some self-etching systems. Studies have found that coarse diamond burs leave relatively thick smear layers as compared to carbide burs. While these smear layers are easily removed with total-etch systems, self-etching systems have difficulty penetrating thick smear layers, and consequently bond strengths will be diminished. Therefore, it is advisable to use traditional carbide burs to prepare dentin surfaces, while the relatively coarse diamonds are used to prepare bevels in enamel.

While the use of mechanical undercuts for retention has not been extensively studied in relation to any adhesive system, it can be argued that undercuts may provide benefit in low retentive preparations under high flexural stress. Clinical presentations such as class V restorations and certain interproximal box preparations where the restorations are under direct occlusal load and there is minimal surface area for bonding may be indications for mechanical undercut retention Mechanical retention should be used sparingly and not at the expense of the axial wall or if it will compromise the strength of the remaining buttressing tooth structure. It is well accepted that modern adhesive restorative materials do not require mechanical undercuts as a primary source of adhesion. However, in certain high-stress-bearing areas, such as proximal box preparations, a less-than-favor-able enamel prism and dentinal tubule orientation may be present, and bond strength alone may not be adequate to withstand occlusal and functional forces.[27] In such areas of high stress/low adhesion, judiciously placed retentive grooves could be beneficial.

**To etch or not to etch?**

Some manufacturers of self-etching adhesives have proposed that an additional phosphoric acid etching step is needed when enamel is not instrumented.[21] Studies have demonstrated that enamel bonds with some self-etching adhesives are improved by etching of the enamel with phosphoric acid. The honeycomb-etch pattern observed in enamel after phosphoric acid conditioning is more pronounced as compared to the pattern seen with self-etching systems. However, immediate shear bond strengths are comparable.[8] Aside from bonding orthodontic brackets, repairing minor fractures or caries limited to enamel, and limited closure of a diastema, it is rare that general dentists will use self-etching systems on unprepared enamel. With only slight modifications to preparation design as outlined above when using self-etching adhesive systems, the cited studies do not support the need for an additional phosphoric acid-etching step for enamel.

Further, it is important to note that at least 2 potentially negative consequences to the routine use of phosphoric acid etching are present in conjunction with self-etching systems. The first and most obvious disadvantage is that by adding the phosphoric acid-etching step, the timesaving benefit of self-etching systems is eliminated.[21] Adding a separate etching step with phosphoric acid, considering the time needed for rinsing and drying and then the subsequent self-etching primer/adhesive application, is equivalent to the number of steps needed for currently available total-etch systems. The second negative aspect of phosphoric acid etching of enamel is that it can be difficult to prevent the phosphoric acid from coming in contact with dentin.

Some studies indicate that phosphoric acid etching of dentin for 15 seconds, either deliberately or by accidental contact while etching enamel, removes the smear layer and can demineralize hydroxyapatite beyond the point that can be penetrated by a self-etching primer/adhesive.[1] The area void of resin infiltration between intact dentin and the hybrid layer is a weak link in the bonding system, and significantly reduces shear bond strength and tensile bond strength.

Others suggest that this demineralized but unfilled area may prove to be the source of leakage as a result of the entrapment of moisture naturally present in dentin below this void area.The mechanism considered to be responsible for the destruction of resin/tooth bonds is the slow hydrolysis of the polymerized resin matrix.Therefore, it is not advisable to allow phosphoric acid to come in contact with dentin, either deliberately or accidentally, when using self-etching adhesive systems.

**Sclerotic dentin: special considerations**

Whereas phosphoric acid conditioning of normal dentin is contraindicated with self-etching systems, clinicians are aware that unaffected dentin is not always present in many clinical situations. Sclerotic or hypermineralized dentin poses an obstacle for most self-etching systems and is commonly found under older, existing restorations.[28] It is visibly identified as glassy in appearance, with little to no surface roughness, and is often stained by earlier carious activity or a long-standing, overlying amalgam restoration. Due to the high mineral content of this type of dentin, some studies recommend applying phosphoric acid to these affected dentin areas for 15 seconds and then rinsing prior to application of a self-etching system. This will help to ensure mechanical adaptation.It was suggested that hypermineralized or sclerotic dentin should be abraded with a diamond bur. While the relative amount of unaffected dentin in the area is an important determinant here, it should be considered that bond strengths of self-etching adhesives to sclerotic dentin that has not been etched with phosphoric acid or abraded are low.

**Clinical technique**

There are a number of self-etching adhesive systems available. For case illustration, Xeno V will be used as an example. It is important to emphasize that the manufacturer's instructions for each specific system should be followed.The use of Xeno V self-etching adhesive is relatively straightforward and involves just a few steps. However, attention to how and where it is applied and its dwell time on the prepared surfaces prior to curing must be closely followed to ensure optimum results.

The product is dispensed in a single bottle. It must be shaken prior to being dispensed. Phase separation with any primer/adhesive combination is possible, and shaking the bottle just a few times allows the components to blend to the desired mixture prior to use.Once the enamel and dentin surfaces have been prepared as previously outlined, the shaken bottle is opened to dispense the adhesive into a disposable dish. As with all adhesives containing volatile solvents, it is important to cap the bottle immediately to prevent the organic solvent from evaporating and ambient moisture from entering.Themicrobrush that is provided is placed into the dish or well with an agitating motion to further stir the mixture, and a copious amount of adhesive is applied to the enamel surface.It is extremely important to extend the coat of Xeno V Bond to and slightly beyond the diamond abraded enamel surface. Failure to extend a self-etching system properly onto the unprepared enamel surface and completely cover the prepared enamel surface may lead to an inadequate marginal seal and subsequent marginal staining.After several passes over the enamel cavosurface, the microbrush is returned to the dish or well, and the brush is again saturated. A copious amount of adhesive is applied to the internal dentin aspects of the preparation to saturate the dentin walls and floor thoroughly. It has been suggested that agitation or scrubbing the microbrush onto the dentin surface may aid in the penetration of the acidic monomers through the smear layer and into dentin. Two consecutive coats of Xeno V bond are applied to all tooth surfaces to ensure a total dwell time of at least 30 seconds. This is extremely important. As with any dentin bonding system, whether total etch or self-etch, adequate time is required for the adhesive to fully penetrate the collagen filigree, pass into the dentin tubules, and reach micromechanical undercuts created by the etching. Failure to allow sufficient dwell time is a common mistake. However, it could be one of the most important causes of adhesive failure and postoperative sensitivity.[1] The complex chemical reactions that must run to completion, particularly with self-etching systems, take time, and practitioners should pay particular attention to the recommended dwell time.

No rinsing, drying, or curing between layers is recommended; Xeno V bond is a single-bottle adhesive, so there are no components to be mixed and no separate primer to be applied. This single product is used for the entire process.

After a dwell time of 30 seconds, the remaining volatile solvent must be evaporated. Failure to eliminate the solvent completely in any adhesive system adversely affects the bonding chemistry. With Xeno V bond, a gentle air stream (not a blast of air, but a gentle, continuous air stream) is passed over the adhesive layer. This air stream is continued for several seconds while the adhesive behavior is observed. Gentle rippling of the adhesive layer under the stream of air means that solvent is still present. Air is continually applied until rippling is no longer present and the adhesive appears still on the tooth surface. Depending on the thickness of the layers applied, this may take from 5 to 10 seconds.

Once the solvent has been volatilized, the adhesive is then light cured for 20 seconds if using a halogen light. The halogen light output must be monitored, and it is recommended to check the output routinely of all halogen lights with a curing radiometer on a monthly basis. Once the self-etching adhesive is light cured, complete dentin tubule penetration and seal should be achieved, and approximately a 5 µm hybrid zone will be established. The dentin and enamel surface is then ready to receive a direct composite restoration.

**Conclusion:**

Demand for simplified systems that avoid some of the complexities of total-etch systems has been answered by self-etching adhesive systems. By eliminating the separate etching step, certain vagaries of this step are no longer present, and the fear of collagen fibril collapse has been eliminated. With a simplified, 1-bottle system, the time needed to place an adhesive and the problem of postoperative sensitivity have been reduced. With proper enamel and dentin preparation, high bond strengths can be achieved; with proper placement of the adhesive well onto the prepared cavosurface margins, aesthetic restorations with optimum marginal seal can be realized.

**References:**

1. Kanca J III. Resin bonding to wet substrate. I. Bonding to dentin. Quintessence Int. 1992; 23: 39-41.
2. Kanca J III. Resin bonding to wet substrate. II. Bonding to enamel. Quintessence Int. 1992; 23: 625-7.
3. Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. J Biomed Mater Res. 1982; 16: 265-73.
4. Brannstrom M. The hydrodynamic theory of dentinal pain: sensation in preparations, caries, and the dentinal crack syndrome. J Endod. 1986; 12: 453-7.
5. Freedman G, Leinfelder K. Seventh-generation adhesive systems. Dent Today. Nov 2002; 21: 106-11.

6. Turkun SL. Clinical evaluation of a self-etching and a one-bottle adhesive at two years. J Dent. 2003; 31: 527-34.
7. Tay FR, Pashley DH, Yiu C, et al. Nanoleakage types and potential implications: evidence from unfilled and filled adhesives with the same resin composition. Am J Dent. 2004; 17: 182-90.
8. Finger WJ, Balkenhol M. Comparative in vitro evaluation of self-etching primer adhesives. Presented at: IADR/AADR 80th General Session; March 6-9, 2002; San Diego, Calif. Abstract 2430.
9. Bates D, Retief DH, Jamison HC, et al. Effects of acid etch parameters on enamel topography and composite resin-enamel bond strength. Pediatr Dent. 1982; 4: 106-10.
10. Retief DH, Busscher HJ, de Boer P, et al. A laboratory evaluation of three etching solutions. Dent Mater. 1986; 2: 202-6.
11. Barkmeier WW, Shaffer SE, Gwinnett AJ. Effects of 15 vs 60 second enamel acid conditioning on adhesion and morphology. Oper Dent. 1986; 11: 111-6.
12. Perdigao J, Lopes L, Lambrechts P, et al. Effects of a self-etching primer on enamel shear bond strengths and SEM morphology. Am J Dent. 1997; 10: 141-6.
13. Gordan VV, Vargas MA, Cobb DS, et al. Evaluation of adhesive systems using acidic primers. Am J Dent. 1997; 10: 219-23.
14. Ferrari M, Goracci G, Garcia-Godoy F. Bonding mechanism of three “one-bottle” systems to conditioned and unconditioned enamel and dentin. Am J Dent. 1997; 10: 224-30.
15. Gordan VV, Vargas MA, Denehy GE. Interfacial ultrastructure of the resin-enamel region of three adhesive systems. Am J Dent. 1998; 11: 13-16.
16. Tate WH, You C, Powers JM. Bond strength of compomers to dentin using acidic primers. Am J Dent. 1999; 12: 235-42.
17. Miyazaki M, Sato M, Onose H. Durability of enamel bond strength of simplified bonding systems. Oper Dent. 2000; 25: 75-80.
18. Matos AB, Tate WH, Powers JM. Influence of enamel surface preparation on composite bond strength. Am J Dent. 2003; 16: 37A-40A
19. Pashley DH, Tay FR. Aggressiveness of contemporary self-etching adhesives. Part II: etching effects on unground enamel. Dent Mater. 2001; 17: 430-44.
20. Erhardt MC, Cavalcante LM, Pimenta LA. Influence of phosphoric acid pretreatment on self-etching bond strengths. J EsthetRestor Dent. 2004; 16: 33-41.
21. Miller M, Castellanos I. In: Reality. Vol 18. Houston, Tex: Reality Pub Co 2004: 269-300.
22. Shimada Y, Kikushima D, Tagami J. Micro-shear bond strength of resin-bonding systems to cervical enamel. Am J Dent. 2002; 15: 373-7.
23. Menghini P, Piacentini C. Aprismatic external layer of deciduous and permanent teeth [in Italian]. Dent Cadmos. 1989; 57: 54-61.
24. Perdigao J, Geraldeli S. Bonding characteristics of self-etching adhesives to intact versus prepared enamel. J EsthetRestor Dent. 2003; 15: 32-42.
25. Sevgican F, Inoue S, Koase K, et al. Bond strength of simplified-step adhesives to enamel prepared with two different diamond burs. Aust Dent J. 2004; 49: 141-5.
26. Milicich G, Rainey JT. Clinical presentations of stress distribution in teeth and the significance in operative dentistry. PractPerioAesthet Dent. 2000; 12(7): 695-700.
27. Shimada Y, Tagami J. Effects of regional enamel and prism orientation on resin bonding. Oper Dent. 2003; 28: 20-27
28. Sturdevant C, Barton R, Sockwell C, et al, eds. The Art and Science of Operative Dentistry. 2nd ed. St Louis, Mo: CV Mosby Co 1985: 277-92.
29. Terry DA, McGuire MK, McLaren E, et al. Perioesthetic approach to the diagnosis and treatment of carious and noncarious cervical lesions: Part II. J EsthetRestor Dent. 2003; 15: 284-96.
30. Santini A, Ivanovic V, Ibbetson R, et al. Influence of marginal bevels on microleakage

around class V cavities bonded with seven self-etching agents. Am J Dent. 2004; 17: 257-61
31. Brackett WW, Covey DA, St Germain HA Jr. One-year clinical performance of a self-etching adhesive in class V resin composites cured by two methods. Oper Dent. 2002; 27: 218-22.
32. Rees JS, Jagger DC. Abfraction lesions: myth or reality? J EsthetRestor Dent. 2003; 15: 263-71.
33. Marshall GW Jr, Chang YJ, Saeki K, et al. Citric acid etching of cervical sclerotic dentin lesions: an AFM study. J Biomed Mater Res. 2000; 49: 338-44.
34. Miller MB. Restoring class V lesions part 2: Abfraction lesions. Pract Periodontics Aesthet Dent. 1997; 9: 505-6.
35. Lambrechts P, Van Meerbeek B, Perdigao J, et al. Restorative therapy for erosive lesions. Eur J Oral Sci. 1996; 104(2 pt 2): 229-40
36. Oliviera SS, Pugach MK, Hilton JF, et al. The influence of the dentin smear layer on adhesion: a self-etching primer vs a total-etch system. Dent Mater. 2003; 19: 758-67.

Source of Support: Nil

Conflict of Interest: Not Declared