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Contributions to Dentistry
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POSITIONING SELF-ETCHING ADHESIVES: *VERSUS* OR *IN ADDITION TO* PHOSPHORIC ACID ETCHING?

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ADHESIVES: ADVANTAGES AND DISADVANTAGES, DIFFICULTIES, AND SOLUTIONS

Coming from the experience of using third- or fourth-generation adhesives, in the past decade dentists have favored the fifth-generation products, which use a one-bottle system. Certainly, there exists an advantage in that there is no possibility of mixing up the different bottles, but a real improvement in operative time has not resulted. One of the first single-bottle adhesives, Prime & Bond® (Dentsply DeTrey, Konstanz, Germany), was a few seconds slower overall than the three-bottle system, Syntac Classic (Vivadent, Schaan, Liechtenstein). The difference in time consumption of the adhesive procedure between the fastest and slowest products is generally not more than 60 seconds when one considers only the procedures outlined in the instruction manuals. Therefore, the ease of application and advantages of storing only one instead of several bottles were the main issues that opened the door to the fifth-generation adhesives' market leadership over third- and fourth-generation products. Along with the fifth-generation products, the total-etch procedure was established in most dental offices.

The classification of adhesives according to generations as described above is a worldwide-accepted system but has become unnecessary because first- and second-generation products are no longer in use. A classification according to generations would make sense if every new generation performed better than the last, but this is not entirely true of the fifth generation.[1–9] (Compare the development to that of computer software; for example, Windows 2000 was better than Windows 98, which was better than Windows 95 [although some computer freaks insist that just the opposite is true!].) New generations in adhesives show significant advantages over fourth-generation products, but one cannot say that they are entirely superior.

As a result, a new classification of adhesives was introduced at a symposium in Philadelphia in 2000 (Figure 1). The classification is no longer according to generations; it is based on the number of different working steps and the treatment of the smear layer. Instead of several generations, there are now four types of adhesives listed: type 1 and 2 adhesives both remove the smear layer with phosphoric acid etching (AE); type 1 adhesives (formerly

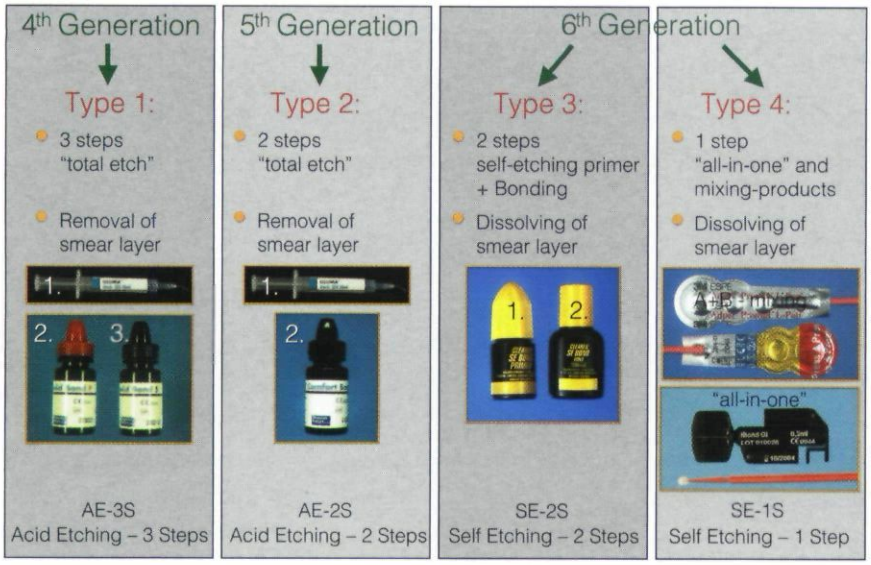

Figure 1. The new and the traditional classifications of adhesives. The new classification is based on the number of application steps and the treatment of the smear layer.

fourth generation) consist of three-step applications (3S; etching, priming, bonding), and type 2 adhesives (formerly fifth generation) combine priming and bonding in one step, resulting in a two-step system (2S). Type 3 adhesives are two-step self-etching (SE-2S) adhesives, in which a self-conditioning primer demineralizes enamel and dentin and is covered with a separate bonding layer. Type 4 adhesives are self-etching as well, but this type consists of two-component mixing products, such as Adper Prompt L-Pop® (3M ESPE, St. Paul, MN, USA), Adhese® (Vivadent, Schaan, Liechtenstein), or Xeno III® (Dentsply DeTrey, Konstanz, Germany), and real all-in-one products (one step [1S]) such as iBond® (Heraeus Kulzer, Wehrheim, Germany). Both the conventional and new classifications are shown in Figure 1.

The total-etch adhesive is a powerful and important element of a successful and long-lasting hybridization of the dentin. It allows dentists to provide high-end esthetics in minimally invasive procedures such as adhesion of resin composites to dentin or an entire adhesive stabilization of the tooth. However, the effect of thin hybrid layers on the integrity of resin-dentin interfaces should be further examined with long-term investigations, even when the thickness of the hybrid layer does not correlate with bond strength.[10,11] A hybrid layer of 1 µm might deliver sufficient bond strength initially but may not be reliable enough in the long term as micro- and nanoleakages may increase over time.[12]

The total-etching procedure resulting in hybridization is a technique-sensitive method; an operator has to be aware of the exact effects and demands of each step he or she is performing. Etching the dentin with phosphoric acid is also a main element of type 1 adhesives, but these procedures were performed predominantly by dentists who were highly experienced in resin composites and total-bonding systems. Upon the introduction of the simplified one-bottle adhesives (type 2), many dentists entered into adhesive dentistry with resin composites in posterior teeth, following the total-bond philosophy without having long-term experience with the total-etching procedure, whereas the highly experienced type 1 adhesive users mainly stayed with their system. This may explain why a lot of users of type 2 adhesives complained about postoperative sensitivity with the use of total-etch type 2 products.

Since operators were not learning the correct total etch–total bonding technique and were making mistakes in their operative procedure that can be estimated to have resulted in > 90% of cases of postoperative sensitivities, it fell upon the manufacturers to develop materials that do not allow for the mistakes that lead to postoperative

sensitivities—overetching and overdrying. To avoid overetching the dentin when using phosphoric acid, it is recommended that one start etching the enamel first (this takes approximately 30 s) and then continue to the dentin. Once the phosphoric acid etching gel is in contact with the dentin, 15 seconds of contact time are allowed, after which all of the etching gel should be removed by rinsing. This technique results in about 30 to 45 seconds of enamel etching and 15 seconds of dentin etching—which exactly matches the demands of the dentin (Figure 2).

Owing to the fact that overetching and overdrying of dentin with phosphoric acid etchant gel are assumed to be responsible for most cases of postoperative sensitivities, materials that do not allow overetching and overdrying would seem to be the best solution. Figure 3 shows the principle of a self-etching adhesive. In a total-etch system involving phosphoric acid, the hybridization follows the demineralization as an independent step and has to be performed exactly so that all microcavities prepared with the etching are subsequently filled entirely with the primer and resin; in a self-etching system the demineralization and hybridization steps take place together. Since both steps are performed together, there is no chance that microcavities created by etching will not be filled and will lead to nanoleakages and a collapse of collagen fibers as a result of overdrying. Collapsed collagen fibers after total etching can build a barrier blocking proper penetration of the adhesive.

Every operator working with the conventional total-etching procedure has to dry the dentin after rinsing the phosphoric acid etching gel according to the demands of the solvent contained in the adhesive. Whereas water as a solvent is able to rewet an overdried collagen fiber network to a certain level and therefore excuses overdrying somewhat, acetone as a solvent requires really wet dentin because it is a kind of "water chaser," which penetrates perfectly into wet dentin (accompanied by the resins). However, the solvent has to be removed afterward when air drying the adhesive because any remaining solvent is a severe polymerization inhibitor. In this step water is the hardest solvent to evaporate, and acetone is the easiest—it almost evaporates by itself. Therefore, the rewetting advantage of water as a solvent is a hindrance when it comes to the next step, evaporation. This is most difficult in Class II proximal boxes, when a matrix band is placed around the cavity.[13] As a consequence of the advantages and disadvantages of water and acetone as solvents, many manufacturers changed the solvent to ethanol, which is easier to evaporate than water but does not require such a wet floor as does acetone (although a moist floor is appreciated).

In addition to potential errors in the phosphoric acid–etching procedure (mostly in the etching time, rinsing of the phosphoric acid, air

Figure 2. Most recommended procedure for enamel and dentin etching with phosphoric acid: first, start with the enamel borders, then continue to dentin; after 15 seconds of contact with dentin, the phosphoric acid is rinsed off.

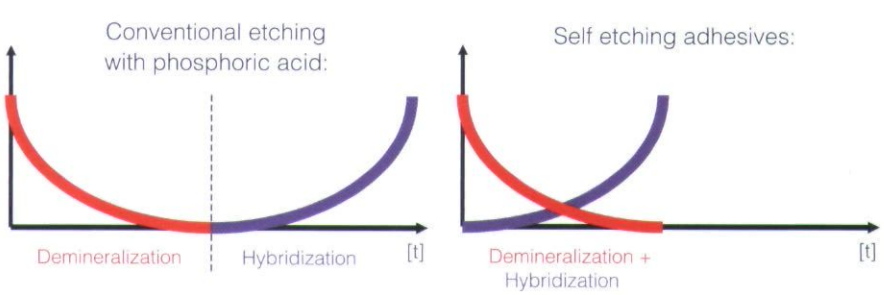

Figure 3. Mode of demineralization and hybridization in conventional phosphoric acid–etching and self-etching adhesives. With phosphoric acid etching the created microcavities have to be filled entirely with the bonding agent, resulting in exactly the same surface below the curve—the most difficult aspect of this technique. With self-etching adhesives both demineralization and hybridization take place at the same time.

drying of the dentin, and air drying of the adhesive), other chances for mistakes must be considered. These can involve the amount of adhesive applied, application technique, penetration time, and light curing of the adhesive, all of which have to be taken into account because they can lead to an early marginal breakdown of the adhesive interface. The need for further developments in adhesives to omit difficulties with phosphoric acid etching of the dentin has been acknowledged,[14] and the self-etching adhesive seems to solve problems with total-etch systems, mainly with type 2 adhesives, because there is no overetching, overdrying, or worries about remaining moisture on the dentin. However, all the other possible mistakes are still present and have to be considered. In some restorations they are even more pronounced than with conventional type 1 and 2 adhesives.

Because of the integration of the etching step (see Figure 3) into the priming procedure (keep in mind that the etching step is not omitted), marketers announced that self-etching adhesives were big time savers and reminded their patrons that "time is money." However, they forgot that real clinical applications take more time than just the application, setting, and exposure times listed in the instruction manual. One has to keep in mind that the reason for the success of the self-etching adhesives in the United States and Europe is not that they save time but that they reduce the problem of postoperative sensitivities.

To summarize so far, self-etching adhesives are not significantly faster than type 2 adhesives, which use phosphoric acid etching, but are much more forgiving in regard to postoperative sensitivities.[15] Therefore, they seem to be the ideal material for dentists still plagued by complaints about postoperative sensitivities and for those situations in which the use of phosphoric acid is not appropriate. Phosphoric acid etching is disadvantageous in Class V restorations because the acid often induces a sulcal bleeding when touching the gumline, and in pediatric dentistry because rinsing and suction can scare the child, causing a severe disturbance in the operative procedure.

Regarding the quality of the bond achieved by self-etching adhesives in contrast to type 1 and 2 adhesives, besides in vivo studies, which are the ultimate test for any dental adhesive material,[16] there are two parameters to determine bond quality in vitro: bond strength and marginal integrity. Reports in the literature regarding the performance of self-etching adhesives are controversial. Although many studies show comparable results in bond strengths compared with conventional pretreatment regimens of dental hard tissues,[17–20] other studies report significantly higher bond strength values obtained with type 1 and 2 adhesives.[1,21] Further, an interesting fact is that bond strength does not correlate with marginal gap formation and a lack of nanoleakages.[22] The correlation between those common laboratory measurements appears to be dependent upon the adhesive system[22]; therefore, one cannot conclude

automatically that data indicating good bond strength also indicate sufficient marginal integrity.

Studies on marginal integrity can be performed on extracted teeth; usually they are performed as studies of Class V restorations (in vivo and in vitro studies) because Class V and I restorations are easy to control and standardize. Studies of Class II restorations are more difficult to execute and result in a greater standard deviation owing to more significant influences of dentin structures and of the operative procedure (matrix systems; sequence of bonding, layering, and curing techniques). As discussed in the literature,[19,23,24] several factors, apart from solvent evaporation, may contribute to the suboptimized marginal integrity observed with some self-etching adhesives. These include the accessibility of the tapered corners of the proximal box with the microbrush; the adherence of self-etching materials to metal matrix bands, which creates a potentially higher C factor; and consecutive air drying, which may produce air voids within the hybrid layer during the process of solvent removal in multiple application steps.[25] Even the origin of the dentin is able to influence bond strength in investigations: data vary significantly, depending on whether the sample was generated from caries-affected, sclerotic, or sound dentin or from superficial versus deep dentin.[26–29] These factors might be the reason why the results of some Class II studies differ from published excellent results typical with self-etching materials in Class I and V studies.[17,30] However, retention rate in a clinical study is affected by various factors in addition to those reported in some in vivo and in vitro studies, as can be seen from studies with a higher loss of restoration (35%) after 1 year.[31]

For Class II restorations, those with the greatest cavity restored, type 1 and 2 total etch–total bond adhesives as well as self-etching materials (types 3 and 4) are the focus of scientists.[13,24,32,33] As mentioned above, a wide variety of in vitro studies attest to the superior performance of type 1 total-etch multistep systems in bond strength and marginal integrity versus self-etching adhesives or even type 2 one-bottle bonds.[1–3,5–9,34] On the other hand, various articles exist showing comparable results in marginal integrity and bond strengths of type 3 and 4 self-etching adhesives versus type 2 products.[35–39] This discrepancy demonstrates that the performance of an adhesive is more dependent upon the operator or application protocol than on its chemical origin or classified generation.[13,25,40–42] Nevertheless, there is no study available that shows a *superior* performance of self-etching adhesives compared with conventional techniques. However, one has to keep in mind that being superior was not the initial aim of the self-etching adhesives; they were intended to be more safe to use and easier to handle. These latter characteristics might lead to superior results in the hand of dentists who are not well practiced in the total-etch technique.

As once expected, self-etching adhesives still have some problems regarding enamel bond, but they seem to work similarly to type 1 and 2 adhesives in dentin (Figures 4 and 5). One might consider performing enamel etching with phosphoric acid in addition to using a self-etching adhesive. Surprisingly, this has little effect in improving bond strength with most of the self-etching adhesives, but it might lead to the reverse effect, especially in esthetically demanding anterior restorations: one has to ensure a sufficient layer of bonding material on the porous and soaking acid-etched pattern to achieve a wettability of the resin composite and to totally fill the microcavities created by this deeper etching. The etching pattern of a self-etching adhesive is not as deep as that with phosphoric acid etching (Figure 6), but it performs a kind of "nanoretention" with the superficial layer compared with etched enamel.[43] These nanoretentions might produce the same bond strength as with conventional etching with phosphoric acid gel. However, this has not been entirely supported from a scientific

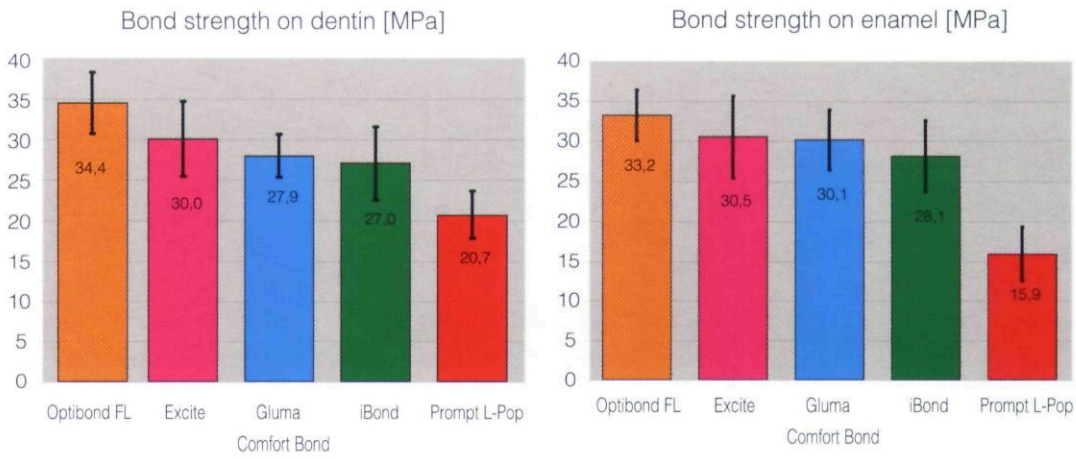

Figure 4. Shear bond strength data of dentin and enamel with various adhesive systems (Optibond FL®, SDS/Kerr, Orange, CA, USA; Excite®, Ivoclar Vivadent, Amherst, NY, USA; Gluma Comfort Bond®, iBond®, Heraeus Kulzer, Hanau, Germany; Prompt L-Pop, 3M ESPE, St. Paul, MN, USA).

standpoint and cannot be generalized because it depends on enamel structure (ground or unground), direction of the enamel prisms (cutting direction), the class of cavity involved, and the product itself and the operator too.

Each adhesive is developed to have a certain penetration ability depending on the etching procedure of the system. Therefore, when adding phosphoric acid etching to a self-etching system, one has to ensure a sufficient bonding layer—a microgap-free interface to the resin composite owing to superficial wetting between the sticky oxygen-inhibited layer and the liquid monomer compounds of the composite (Figures 6 and 7). Those micro- or nanogaps, resulting not from shrinkage but from a weak adaptation of the resin composite to the oxygen-inhibited layer of the bonding agent, might soak up water over time because of the monomeric nature of inhibited surfaces inside the gaps. With the water, colored pigments from food and beverages are deposited. This kind of marginal staining may result in the fastest and most intensive discoloration process around the restoration in the region of etched enamel. This effect can be worse when the resin composite is "squeezed" over the margins instead of being gently adapted (see Figure 7). A squeezing of resin com-

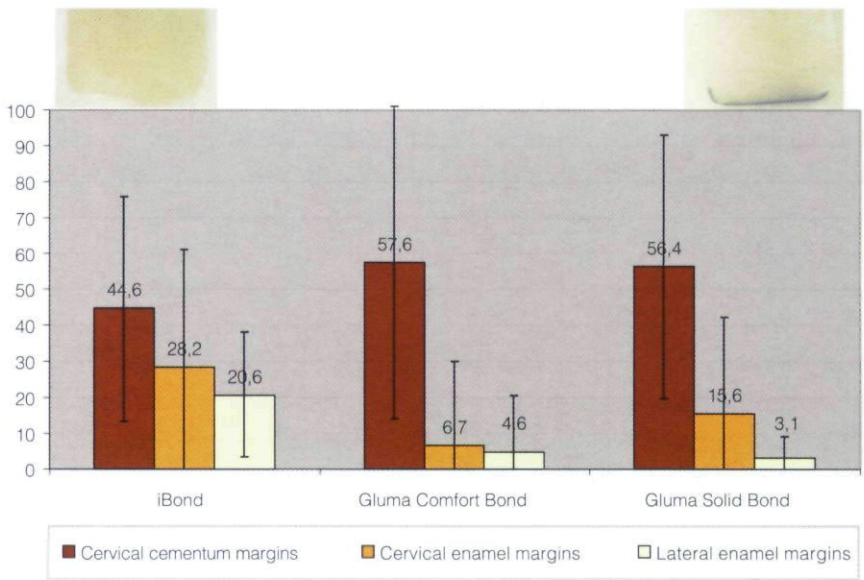

Figure 5. Marginal integrity of type 1 (Gluma Solid Bond), 2 (Gluma Comfort Bond), and 4 (iBond) adhesives of the same manufacturer (Heraeus Kulzer, Wehrheim, Germany) in Class II proximal boxes. Although there are comparable results in the cervical cementum margins, in enamel better results were obtained with conventional phosphoric acid etching.

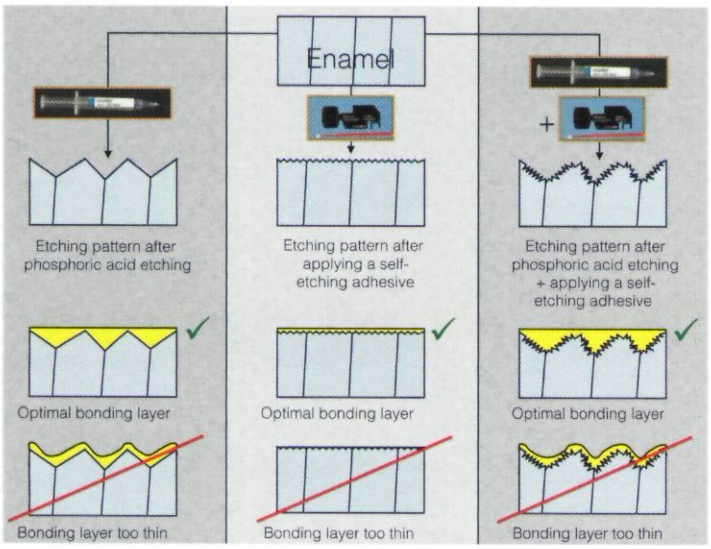

Figure 6. Differences in resulting enamel etching patterns have to be considered when etching with phosphoric acid, self-etching adhesives, or both. The created microcavities have to be filled with the bonding afterward to ensure a gap-free contact with the resin composite.

posite results in a positioning of the filler particles toward the surface, with most of the resin stuck within the spaces between the filler particles. The consequence is an even more pronounced inhibited layer on both sides (bonding and composite). However, one has to keep in mind that this problem is not exclusive to self-etching adhesives; insufficient bonding layer thickness generally exists with conventional phosphoric acid etching too, although not as severe and pronounced as with self-etching adhesives.

Marginal staining may also develop in gaps resulting from a disintegration owing to polymerization shrinkage and from a potentially higher water uptake into a self-etching adhesive compared with type 1 and 2 materials. The higher hydrophilia of self-etching adhesives might lead to a kind of marginal staining but, in contrast to the above types of staining, is not the result of micro- or nanoleakage but of a discoloration of the adhesive itself. This might be a visible effect of water sorption—a phenomenon that initiates hydrolysis of resin polymers and even leaching of monomeric or oligomeric resin components from the resin-dentin interfaces over the long term. This occurrence is not based on the mode of demineralization (acidic monomers vs phosphoric acid); it is mainly correlated to the hydrophilia of the self-etching adhesives, which, besides having more hydrophilic monomers than do conventional adhesives, mostly use water as a solvent. The problem for the clinician is the difficulty in differentiating between a discolored bonding layer and a marginal discoloration owing to a microleakage caused by shrinkage

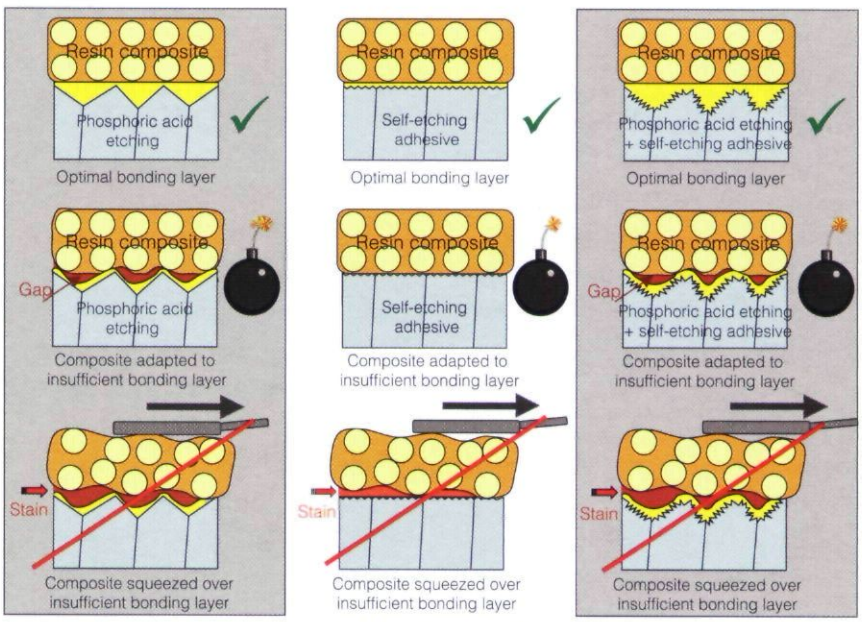

Figure 7. Insufficient (too thin) bonding layers will result in a worse adaptation of the resin composite. The remaining oxygen-inhibited layer might show discolorations (staining) immediately. This effect can be pronounced when the resin composite is squeezed over the margins instead of being adapted.

or insufficient adaptation. Because of the importance of the esthetic appearance of an adhesive restoration (in addition to ease of application, bond strength, and marginal integrity), this concept needs to be the subject to further research.

WHICH TO USE: CONVENTIONAL OR SELF-ETCHING ADHESIVES?

So, which should one choose—the conventional or self-etching adhesives? The answer is not difficult: both! It makes no sense to replace a well-established total-etch system if the operator has good results and no problems with postoperative sensitivities. A system should be replaced by a new one only when the latter offers significant advantages over the established system. Consider the following as they relate to the self-etching adhesives compared with the conventional ones:

- Better bond strength. This is definitely not the case with self-etching adhesives; they can reach almost the same bond strengths as conventional adhesives (see Figure 4) in dentin *and* enamel, but with certain limitations in the clinical use. In general, the quality of the bond to enamel is still the highest with phosphoric acid etching.[18,44]
- Better marginal integrity. This depends on the type of hard tissue and the cavity in which the adhesive is used. In cervical cementum margins of Class II restorations, self-etching seems to work as well as conventional adhesives, but there still seem to be more problems related to enamel (see Figure 5). This might be due to difficulties in the application protocol and not in the material itself. However, marginal integrity is, in fact, a more important parameter because it is the clinically demanding issue. In Classes V and I, the excess removal and the solvent evaporation can be performed well. Therefore, where a lot of dentin has to be sealed (as in Class V restorations) or a cavity exists that allows proper excess removal and solvent evaporation (as in Class I and V restorations), the self-etching adhesives might perform as well clinically as do conventional type 1 and 2 adhesives.
- Postoperative sensitivities. In this area, self-etching adhesives have a real advantage. A problem with postoperative sensitivities in the operative procedure is a good reason to change to a self-etching system.
- Time saver. Yes, you might be 60 seconds faster when using a self-etching adhesive instead of one with phosphoric acid etching, but are you really going to change your time schedule of appointments for posterior resin composites from 30 to 29 minutes? This is not a reason to switch to the self-etching system.
- Cost. The self-etching systems are generally not cheaper. (Have you ever known an innovative material in dentistry to be offered cheaper than its predecessor?)
- Ease of use. Self-etching adhesives are easier to use. This is obviously true in a Class V restoration. When a rubber dam is not used, phosphoric acid gel touching the gumline is a frequent complication. It can induce sulcal bleeding, which significantly affects the subsequent operative steps. This problem does not occur with self-etching adhesives. Regarding pediatric dentistry, the omission of the rinsing step of the phosphoric acid is a big advantage; the rinsing disturbs the treatment process as the child is often frightened by the noise of the suction. In a Class II restoration, self-etching adhesives are not easy to use owing to the problems with the proximal boxes surrounded by a matrix. The main issue is proper solvent removal while establishing a sufficient bonding layer. Air drying of an adhesive has to start with gentle drying followed by a sufficient stronger drying until no surface movements (an obvious sign of remaining solvent) are visible anymore. Afterward, the surface must show a shiny appearance, the visible sign of sufficient adhesive on top of the tooth structure. Checking of visible controls and potential reapplications definitely cannot be performed in 15 seconds. Remember, five of eight possible mistakes in using adhesives are still present with self-

etching adhesives and have to be considered; in the case of solvent evaporation, self-etching adhesives are almost more difficult to handle than are conventional type 1 and 2 adhesives.

THE PERFECT UNIVERSAL ADHESIVE?

Is there a perfect universal adhesive for all indications? No, there is none available. It would be desirable to have only one adhesive system for all cavities. Fewer storage expenses and better control of materials in the office would be advantages—and staff would only have to be trained in the use of one system instead of two or more. However, until such a universal adhesive is provided, dentists must accept having several adhesives for different indications. In the dental office this can be reduced to two systems: (1) a conventional adhesive using phosphoric acid gel (type 1 or 2 products) for all the Class II restorations and restorations with high esthetic demands such as Class IV restorations and some Class III restorations; and (2) a self-etching adhesive (type 3 or 4) for Class V restorations, most Class I cavities, and pediatric dentistry. If there are problems with postoperative sensitivities, then this latter type of adhesive is needed for further indications as well.

If one takes this type of approach to adhesives, each adhesive can offer advantages in its particular use. This might create better overall results than if one insists on using a particular adhesive in all situations. The best adhesive is that which easily performs sufficiently not in a flat enamel and dentin surface in a laboratory investigation but in the clinical environment—the particular tooth cavity.

CONCLUSIONS

The following conclusions may be made regarding the use of adhesives:

- Self-etching adhesives are an excellent supplement to existing conventional adhesives, but there is no clinical need to replace the latter entirely.
- Clinical studies have proven that self-etching adhesives work sufficiently well in Class I and V and restorations (Figures 8 and 9).
- In pediatric dentistry self-etching adhesives allow for a smoother treatment session because the rinsing and suctioning are not needed. The bonding to primary enamel seems to work well clinically.[34,45]

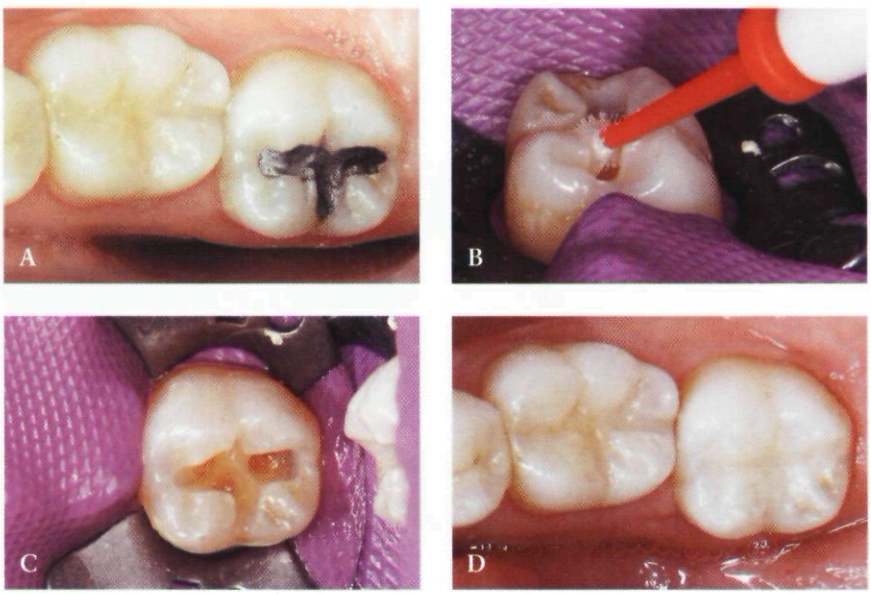

Figure 8. Class I restoration. Depending on the cavity size and preference of the operator, either self-etching or phosphoric acid etching will work. Owing to the fact that a lot of operators report postoperative sensitivities, a self-etching adhesive might have an advantage in these cases. A, *Second lower molar. Old amalgam restoration with marginal breakdown.* B, *Application of a self-etching adhesive starting from the enamel margins and then directing the application to the cavity floor. This protocol ensures sufficient etching efficacy at the enamel margins.* C, *The sealed cavity. The important visible control shows a carefully air-dried shiny cavity surface without any further movement within the adhesive layer during air drying.* D, *The cavity was restored with a submicrometer hybrid resin composite.*

Figure 9. Class V restoration. Even in larger Class V restorations than this one, with significant dentin to seal, a self-etching adhesive is the material of choice. A, *Cervical lesion at first upper molar.* B, *Cavity after application with a self-etching adhesive. A big advantage is that no bleeding will be initiated close to the sulcus by etching with phosphoric acid.* C, *Class V restoration after finishing and polishing.*

- In Class II and IV restorations (Figures 10 and 11), conventional adhesives are still the better choice owing to optimized marginal integrity and a reduced risk of marginal staining in esthetic restorations.
- The choice of adhesive in Class III restorations might depend on the location and size of the cavity.
- Most of the self-etching adhesives *need* cut enamel to obtain proper bond strength there.[46] Therefore, self-etching adhesives used in fissure sealing and luting brackets might not work as desired if a prior cutting has not been carried out.[47] On the other hand, there are studies that show similar bond strengths on ground and unground enamel[48–50] and even in the sealing of fissures.[51] However, since there is no final consensus available and this discrepancy might be related more to the brand than the adhesive type, the practitioner should be advised to work on only ground enamel with most self-etching adhesives.
- An additional enamel etching is beneficial with some self-etching adhesives,[52] but this depends largely on the material itself. When performing additional phosphoric acid etching, one has to ensure a bonding layer thickness sufficient to allow a proper contact to the resin of the composite to prevent microgaps

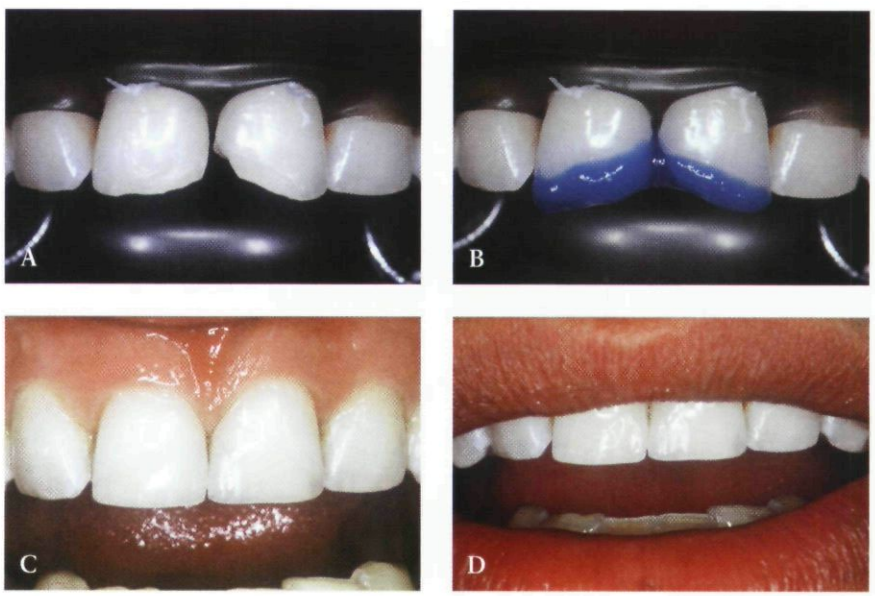

Figure 10. Class IV restoration. If the highest bond strength and color stability have to be ensured, a type 1 or 2 adhesive is the material of choice. A, *Anterior trauma of central incisors; the highest bond strength and an esthetic appearance of the restoration are crucial.* B, *Phosphoric acid etching is the fundamental principle of long-term stability.* C, *Both central incisors were restored with a submicrometer hybrid resin composite using an opaque dentin core (OA2) and regular (A1) shades.* D, *A clinically esthetic restoration has been achieved.*

Figure 11. Class II restoration. Independent of the size of the cavity, the conventional type 1 and 2 adhesives are the materials of choice. Larger cavities demand the highest bond strength, whereas in a smaller minimally invasive cavity, sufficient removal of excess adhesive and evaporation of the solvent are difficult. A, *Restoration of a root canal–treated tooth. An adhesive stabilization of the tooth is crucial for its longevity.* B, *Phosphoric acid etching of the entire cavity (total etch, total bond).* C, *A flowable applied after the type 1 adhesive was polymerized.* D, *The premolar entirely restored with a submicrometer hybrid resin composite.*

between the adhesive and the resin composite, which might show up clinically as marginal staining. Even if scanning electron microscopy shows a retentive pattern not as clear as with phosphoric acid etching, the retention in enamel might be clinically acceptable owing to a kind of nanoretentive interlocking between enamel crystallites and resin.[43,53] In most cases dentin etching with phosphoric acid in combination with self-etching adhesives does not result in higher bond strength, and there is a chance that the reverse effect might occur if the etching pattern of the enamel is insufficiently filled.

- It is important to remove the solvent of the adhesive thoroughly; if not, there may exist areas of increased permeability within polymerized resin matrix in which water is incompletely removed, resulting in regions of incomplete polymerization and/or hydro gel formation.[54]
- Type 4 self-etching adhesives do not work with the self-setting reaction of dual- or only chemically curing resin composites because their acidity destroys the amines in self- and dual-cured resin composites.[55]
- The instruction manual must be followed closely.

DISCLOSURE

The author has no financial interest in any of the companies whose products are mentioned in this article.

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