Seven ways to increase dentine bond strength

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If you battle with debonding restorations, post-operative sensitivity or microleakage, weak adhesion to dentine could be your problem. There are multiple factors that can affect the quality of dentine bonding, many of which are overlooked or unknown. Furthermore, it can be difficult to see the impact of these factors in a clinical setting.

The research and development team at Ultradent Products has performed tens of thousands of laboratory tests to find the most fool-proof process for effective dentine bonding by introducing different variables. Before approaching these steps, however, it is critical to ensure that some fundamentals are in place.

Fundamental bonding requirements

When bonding to dentine, remember that bonding can only be predictably performed on hard mineral dentine. All affected soft tooth structure must be removed to achieve adequate and maximum bond values. Adhesive or minimally invasive dentistry is not dictated by cavity preparation design, but rather by simply excising the lesion. Quality adhesive reconstruction will be durable if attention is given to detail.

Tissue management is paramount. The clinician must be in control of all oral fluids before preparation design, but rather Adhesive or minimally invasive infected soft tooth structure must be considered. Remember that bonding can be impaired by the presence of saliva, blood, alcohol, or any other substances that come into contact with the etched surface. The definition of contamination is the presence of any substance that comes between mineral mother dentine and the adhesive (Figs. 2a–f).

Laser-prepared surfaces on both dentine and enamel do not create the ideal surface for bonding. In fact, laser preparation can contribute to a 20 per cent reduction in bond values, on average, due to microscopic fracturing of the surface. In order to regain the highest bond value, it is imperative to freshen every laser-prepared surface with a diamond bur prior to etching. 1,3

With these bonding best practices in place, clinicians can increase bond strength even further by incorporating findings from Ultradent’s laboratory testing. These laboratory tests resulted in seven simple controllable steps for ensuring the highest quality bond strength, which are described below.

1. Etch for the appropriate length of time

Whether you are using self-etch or phosphoric acid etch, etch for the appropriate length of time. Most phosphoric acid etch preparations can etch too deeply if left for too long on the surface. A fumed silicate-type phosphoric acid like Ultra-Etch (Ultradent) is more forgiving in this regard (Fig. 5).

2. Ensure ideal dentine moisture conditions

Manufacturers use solvents (acetone, ethanol, water) in adhesives to thin out the adhesives to flow into the depths of the etched zone. Since the solvents used are hydrophilic, they will actively carry the primer or adhesive into moist dentine better than into dry dentine. Each etchant type works differently with moisture levels. Ideal conditions for each are described below.

Acetone-containing adhesive systems

Ensure that the dentine surface is glistening with moisture. This can be easily achieved by using a cotton pledget and dabbing off the excess moisture. Adhesives that contain acetone are particularly sensitive to overdrying. If the tooth surface is not moist prior to adhesive application, a substantial loss in bond strength will result.

Ethanol-containing adhesive systems

Adhesives that contain ethanol do not require as much moisture. Leave the dentine surface damp by using the air syringe for no more than 1 second, blowing off visible surface moisture. Do not direct any substantial sustained air at the surface. A chalky white or over-dried surface will decrease bond value.

Self-etching adhesive systems (water-containing)

Systems that contain water can be placed on slightly drier surfaces. The water in the self-etch adhesive is the carrier for its acid. Thin 1–3 seconds prior to adhesive application.

3. Pay attention to application time and technique

It is important to leave adhesives in place for as long as recommended by the manufacturer. In a busy dental practice, it is easy to count too quickly, watch the clock instead. It is crucial to give the adhesives time to penetrate or wet the deepest zones to be etched. With self-etch adhesives being less acidic than phosphoric acid is, it is important to leave the adhesive in place for long enough to etch and penetrate the dentine and enamel properly. Also, ensure that you scrub in the adhesive if the manufacturer recommends it. Usually, scrubbing adhesives into dentine will increase bond strength by a few per cent and allow for a much more consistent and reliable bond. Conversely, scrubbing enamel will slightly decrease bond strength. When possible in the same preparation, treat enamel more delicately and dentine more aggressively.

4. Thin and dry the adhesive properly

All adhesives should be dried before they can polymerise properly. This means that all adhesives need to be aired so that they are paper thin (in the case of Peak Universal Bond) and then air-dried.

The best way to accomplish this is with a gentle air stream, using half pressure, at 5–5.5 cm from the surface. A properly thinned adhesive will appear uniformly glossy without pools. Posed product contributes to a substantial decrease in bond strength due to trapped solvents. Leave the air on for long enough in a gentle stream so that there is no movement in the resin, just drying, to finish volatilising the solvents. This allows monomers to polymerise properly for the highest bond strength possible.

5. Light cure close to the surface with a compatible light

Place the curing light as close to the restored surface as reason-ably possible. This ensures that the materials are exposed to suf-ficient energy for a proper cure. At a distance of 25 mm, most lights will only produce 10 per cent or less of the energy than they do at 1 mm. Only a few of the newest generation of LED lights produces a colour that is compatible with the mean-ing that they actually emit more than one colour of blue.

This is important owing to the fact that many dental materials contain initiators (light-sensitive chemicals) that react to deeper blue and violet colours.
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[*] Based on research by Strategic Data Marketing. Dental product categories include chairs, delivery systems, lights, and cabinetry.

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6. Place the first increment of composite in a super-thin layer. In order to achieve a monoblock restoration (tooth, adhesive and composite acting as one), it is important to place the first layer of composite at a depth no greater than 0.2 mm so that thorough and complete adaptation can occur.

If a thicker first layer is applied, it is likely that slight voids will result beneath the composite, which can be a point of failure over time.

After the first layer has adapted, place standard increments of 1–2 mm in thickness. Another way to improve adaptation to the adhesive layer is to use a flowable composite for the first layer. However, avoid bulk filling owing to stress build-up issues.

7. Never use an expired product

Since all restorative materials contain reactive components, it is important to refrigerate materials that are not used on a daily basis in order to slow the degradation process. The higher the temperature, the faster the chemistry will react and become unsuitable for use. Manufacturers give expiration dates based on data that shows when the product becomes unacceptably degraded.

At Ultradent, we typically set that marker at not less than 90 per cent of new performance, meaning that the product’s performance has not decreased by any more than 10 per cent since it was manufactured. Typically, it is even less than that. When the expiration date arrives, it does not mean that the product has suddenly gone bad, but it means that the product has reached a marker set by that manufacturer.

Products that contain solvent are subject to problems with evaporation. Tighten the lids of these products securely in order to reduce the risk of solvent loss, which could lead to poor product performance.

Conclusion

Many clinicians can increase dentine bond values in their practice by incorporating a few simple practices into their bonding procedures. It is important to start with a solid understanding of bonding fundamentals. After this base has been established, seven controllable steps contribute to the final bond value achieved; in combination, this increase or decrease can be dramatic.

Editorial note: A complete list of references is available from the publisher.

Conflict of interest: Dr Dan Fischer is President and CEO of Ultradent Products.

Dr Dan Fischer has been extensively involved in the research and development of many products used widely in the dental profession, with numerous US and foreign patents granted and pending. In addition to his position as CEO of Ultradent Products, he serves as an adjunct professor at Loma Linda University and the University of Texas at San Antonio in the US. He can be contacted at info.my@ultradent.com.