> **An ongoing challenge in the art of bonding might be described as "technique sensitivity."**

Key Words: zirconia, adhesives, bond strength, self-etching adhesives, technique sensitivity

Dr. Bunek Discusses the Realities of Understanding Bonding Material

It is no myth that dentistry encompasses both art and science. The art and science of bonding are often supported by laboratory and clinical studies. An ongoing challenge in the art of bonding might be described as "technique sensitivity."[1] Parameters that affect technique sensitivity include patient and placement variables. The ability of an adhesive to minimize technique sensitivity often affects its success in both direct and indirect bonding procedures. Clinicians' perceptions may also affect the success of bonding.

Table 1: Shear Bond Strengths of Self-Cured Clearfil Esthetic Cement with Clearfil Ceramic Primer to As-Sintered Zirconia with Different Treatments.

Treatment	Bond Strength,* MPa	
	24 Hours	Thermal Cycling
Cement only-as-sintered zirconia	14.0 (3.0)* [100A]	9.6 (2.0)[b] [100A]
Primer/Cement-as-sintered zirconia	23.0 (6.1)a [97A/3C]	11.7 (1.4)b [100A]
Primer/Cement-bur ground zirconia	26.9 (5.0)a [96A/4C]	18.6 (6.4) [100A]
Primer/Cement-sandblasted zirconia	36.4 (9.2) [96A/4C]	27.4 (8.2) [100A]
*Means with standard deviations in parentheses (n=8). A=adhesive failure, C=cohesive failure in cement.		

Myth
It is not possible to bond to zirconia restorations.

Reality
Recent major advances in resin cements and substrate primers are now allowing clinicians to bond zirconia restorations with confidence. As the demand for esthetic restorations is increasing, so are options in all-ceramic materials. Silica-based glass ceramics (i.e., lithium disilicate, leucite-reinforced, feldspathic) have an etchable surface, enabling a strong bond. Oxide-based ceramics (zirconia and alumina), on the other hand, do not have an etchable surface, and many clinicians assume that they cannot be bonded.

When tooth preparations exhibit good retention and resistance form, self-adhesive resin cements (containing MDP monomers) are recommended.[1] Although laboratory testing shows self-adhesive resin cements have lower mechanical properties than adhesive resin cements, they offer clinicians other benefits, such as low technique sensitivity, low postoperative sensitivity, and easy cleanup.[1]

Long-term performance studies conducted by *The Dental Advisor* for self-adhesive resin cements have shown excellent results. In an eight-year recall of 1,094 zirconia restorations bonded with a self-adhesive resin cement (Unicem; 3M ESPE; St. Paul, MN) without use of a ceramic primer, it was reported that postoperative sensitivity was less than 1.1%, marginal discoloration was 8%, and retention was 97.6%.[2] In a one-year recall of 78 zirconia restorations bonded with a self-adhesive resin cement (G-Cem, GC America; Alsip, IL) without use of a ceramic primer, it was reported that postoperative sensitivity was less than 1.3%, marginal discoloration was 0%, and retention was 100%.[3] In a one-year recall of 196 zirconia restorations bonded with a self-adhesive resin cement (Clearfil SA Cement; Kuraray America; New York, NY) used with a ceramic primer (Clearfil Ceramic Primer), it was reported that postoperative sensitivity was 1.0%, marginal discoloration was 0%, and retention was 98.5%.[4]

When retention and resistance form are not ideal, cementation with adhesive resin cement is recommended with the use of a zirconia primer (e.g., Z-Prime Plus, Bisco; Schaumburg, IL; Monobond Plus, Ivoclar Vivadent; Amherst, NY; Clearfil Ceramic Primer).[1] Zirconia primers contain phosphate monomers that form covalent bonds with zirconia and double bonds that bond to the resin cement.[5] Studies show that the use of a zirconia primer significantly improves bond strength to zirconia.[6,7] A 2008 study **(Table 1)** shows that sandblasting zirconia can provide higher shear bond strength, rather than using primer and cement only.[8]

Myth
Using a strong adhesive with good long-term clinical data ensures success.

Reality
This statement is true most of the time. However, recent attention has been drawn to how the improper use of light-curing units may negatively influence successful adhesive outcomes. In a 2010 study,[9] 20 operators (10 dentists and 10 dental students) were instructed to use three new curing lights on Class I and Class V simulated restorations. The results showed no statistical difference between dentists and dental students; however, there were statistically significant differences in energy delivered to the restoration among operators. Some

Figure 1: Check light tip frequently for debris or damage.

Table 2. Effect of Air-Blowing Intensity on Microtensile Bond Strength (MPa) of Two Self-Etching Adhesives.

Intensity	Clearfil Tri-S Bond (Kuraray)	Fluoro Bond Shake One (Shofu)
Gentle	4.1 (2.4)*	13.1 (3.1)
Intensive	42.6 (3.8)	5.4 (2.9)

* Means with standard deviations in parentheses.
Adapted from Shinkai K, Suzuki S, Katoh Y. Dent Mater J 25(4):664-668, 2006.

operators delivered only 20% of the energy achieved by other clinicians using the same unit and same location. It was concluded that operator technique, choice of curing light, and location of preparation were the reasons for the large degree of variation.[9] The results are cause for concern, as they show that inadequate polymerization adversely affects the resin's physical properties and reduces bond strength, along with other implications.[10-12]

It is our responsibility as clinicians to understand all the variables that influence successful adhesive outcomes. Something as simple as using a curing light that is not properly calibrated can be the demise of our restorations. It is critical to regularly check the output of the light-curing unit, inspect the tip for debris or damage **(Fig 1)**, pay attention to distance,[13] and aim the beam perpendicular to the resin surface.

Myth

Total-etch adhesives are more technique-sensitive than self-etch adhesives.

Reality

Self-etch adhesives do not require a separate etching step, which is different from total-etch (etch-and-rinse) adhesives. Consequently, clinicians consider them to be more user-friendly and less technique-sensitive. Because self-etching systems are water-based, and not highly susceptible to volatilization, they require a different technique to remove the solvent than do total-etch systems.[14] Studies have shown that variables such as air-drying (gentle versus aggressive)[15] **(Table 2)**, duration of air-drying,[16,17] active or passive application of adhesive,[18,19] application time,[20] and number of layers[20] all have an effect upon bond strengths.

Application of the self-etching adhesives is technique-sensitive and requires meticulous attention to instructions. Although they have fewer components, clinicians need to pay as much attention to application technique as they do with total-etch systems.

Myth

Self-etching adhesives do not exhibit good long-term performance.

Reality

Clinical long-term performance is the true test of an adhesive. In a clinical setting, adhesives must survive in the oral cavity, including the complexity of different bacteria, changes in pH, and occlusal forces; and must demonstrate ability to survive in a warm, moist, or wet environment.[12] The hydrophilicity of self-etching adhesives is a concern because the bond may degrade over time, as these materials are more susceptible to water sorption.[21] Although some laboratory data show degradation of some self-etching adhesives after thermocycling,[22] there are long-term clinical studies that show promising success with certain other commercial self-etching adhesives.[23-26]

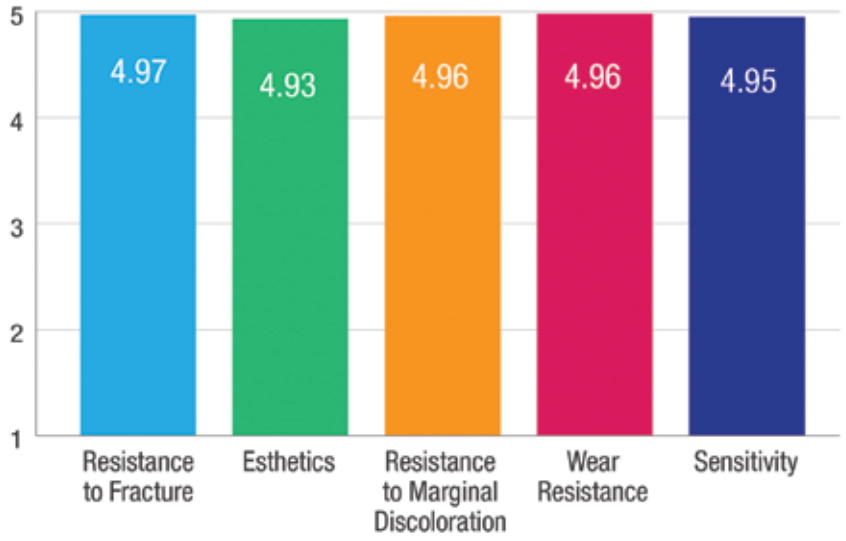

Figure 2: Clearfil Majesty Posterior at two-year recall.
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In a four-year clinical evaluation,[23] a one-step self-etch adhesive was compared to a two-step etch-and-rinse adhesive. In this study, 165 Class II restorations were placed with both adhesives. At the end of the study, no significant difference was seen in overall clinical effectiveness between the two adhesives.[23] In another study, a two-step self-etch adhesive was used with and without selective etching in 100 non-carious Class V restorations.[24] After five years, the clinical effectiveness of the two-step self-etching adhesive remained excellent. It was noted that additional etching of the enamel cavity margins resulted in an improved marginal adaptation on the enamel side; however, this was not critical to the success and longevity of the restorations.[24] In continuation of this study,[24] the restorations were recalled three years later. After eight years in function, it was concluded that the clinical effectiveness of the adhesive remained excellent with selective etching.[25] In a two-year clinical study conducted by *The Dental Advisor*, 605 Class I, II, and V restorations were placed using one-step self-etch adhesive (Clearfil S3) and restored with Clearfil Majesty Posterior (327 restorations were available for evaluation at 24 months). All restorations exhibited excellent esthetics and resistance to marginal staining and fracture, and no sensitivity was reported at recall **(Fig 2)**.[26]

Summary

Improvements in physical, chemical, and mechanical parameters are attractive in laboratory studies; however, the real test of a material's success is in a clinical setting. The material not only has to withstand the conditions in the oral cavity, but it also must be manipulated properly by the dental team. As highlighted in some of the cases discussed above, technical errors can work against material advancements. It is therefore extremely important for the entire dental team to understand basic material science and how to properly manipulate a material.

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Disclosure: Dr Bunek is part owner of Dental Consultants Inc., which publishes *The Dental Advisor*.