Self-Adhesive Resin Cements—Part I

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A recent Medline search revealed 214 publications related to the search term "self-adhesive resin cements." The Journal published a Critical Appraisal on these materials by Burgess and colleagues in late 2010 (J Esthet Restor Dent 2010;22:412–9). One hundred fifty-eight of those were published in 2009 or later, so the knowledge base on this subject is growing rapidly. With that in mind, we thought it would be helpful to provide an update. The update will be presented in two parts. Here in Part I, the specific topics addressed are bonding to tooth structure, bonding to zirconia ceramics, and effects of curing mode.

Immediate Bonding Effectiveness of Contemporary Composite Cements to Dentin

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Clinical Oral Investigations 2010 (14:569–77)

ABSTRACT

Objective: The purpose of this study was to compare the early (1 week) dentin bond strengths of resin cements and to identify an appropriate processing method for pretest failures.

Materials and Methods: The cements evaluated in this study included two etch-and-rinse materials (Calibra [Dentsply DeTrey, Konstanz, Germany] and Variolink II [Ivoclar Vivadent, Schaan, Principality of Liechtenstein]), two self-etch materials (Panavia F2.0 and Clearfil Esthetic Cement, both from Kuraray, Tokyo, Japan), and five self-adhesive resin cements (RelyX Unicem [3M ESPE, Seefeld, Germany], Maxcem [Kerr, Orange, CA, USA], Monocem [Shofu, Kyoto, Japan], G-Cem [GC, Tokyo, Japan], and Multilink Sprint [Ivoclar Vivadent]). Coronal enamel was removed from intact extracted human molars. The exposed dentin was polished to 600 grit with silicon carbide abrasive papers to create standardized smear layers. Ceramic blocks (Vita Mark II, Vita Zahnfabrik, Bad Säckingen, Germany) were sectioned into smaller 8 x 8-mm blocks that were approximately 4.15-mm thick. These were etched with hydrofluoric acid, silanated, and coated with an unfilled resin bonding agent (which was not light-activated). The ceramic blocks were luted to dentin using the various resin cements according to manufacturer recommendations under a fixed pressure. The cements were light-activated using a halogen curing device for a total of 100 seconds (20 seconds from the top and each side). As a control, ceramic specimens were bonded to dentin using a composite restorative material and the two-step self-etch adhesive system Clearfil SE (Kuraray). The bonded specimens were stored in water at 37°C for 1 week. They were sectioned using a diamond saw to obtain "sticks" with a cross-sectional area of approximately 1 mm^2. These sticks were fixed to a microtensile testing device and loaded in tension to failure on a universal testing machine. Microtensile bond strengths (μTBS) were calculated in three ways: (1) with pretest failures counted as having zero bond strength; (2) with pretest failures counted as the lowest

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bond strength value actually measured; and (3) without including pretest failures. A stereomicroscope with a magnification of 50× was used to evaluate and classify failures as adhesive, cohesive, or mixed.

Results: The statistical outcome varied according to inclusion of the pretest failures, a finding that is of interest more to researchers than clinicians. The control two-step self-etch adhesive and restorative composite always had a higher µTBS than any of the cements. Among the cements, the highest µTBS values were obtained using the etch-and-rinse materials Calibra and Variolink, the self-etch Panavia F2.0, and the self-adhesive cements RelyX Unicem and G-Cem. The bond strengths of the self-adhesive cements Maxcem, Monocem, and Multilink Sprint were significantly lower than those of the other cements, and all three had a large number of pretest failures. Failure analysis showed a mixed failure pattern for most of the cements. There was a trend towards more adhesive failures at the dentin-cement interface for the cements with lower bond strengths and towards more adhesive failures at the cement-ceramic interface for those with higher bond strengths.

Conclusions: Depending on the cement system, an adequate bond of ceramic to dentin can be obtained, even with self-adhesive resin cements that—by definition—do not use a separate adhesive. However, the self-etch adhesive Clearfil SE Bond combined with restorative composite had a superior bonding performance and should be considered in clinical situations where the restoration transmits light sufficiently.

COMMENTARY

As a general rule, resin cements using an etch-and-rinse adhesive have higher bond strengths to dentin than those using a self-etch primer. In turn, cements using self-etch primers have higher bond strengths than the self-adhesive resin cements that do not require a primer or bonding agent. Despite the potential for higher bond strengths with etch-and-rinse systems, the self-etch approach is attractive due to the potential for less post-cementation sensitivity. The self-adhesive approach is perhaps even more attractive because it adds the benefit of clinical simplicity. The present study suggests that some—but not all—self-adhesive resin cements can provide dentin bond strengths similar to those of clinically proven self-etch cements. For example, the mean bond strengths and failure modes of RelyX Unicem were nearly identical to those of Panavia F2.0.

Much of the in vitro research on self-adhesive resin cements has focused on their bond to dentin, but some work on enamel bonding also has been reported. Enamel bond strengths are fairly low, but can be improved by phosphoric acid-etching. Etching can be followed by application of an adhesive, but this defeats the purpose of a simplified cementation technique.

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 DOI 10.1111/j.1708-8240.2012.00521.x

In Vitro Comparative Bond Strength of Contemporary Self-Adhesive Resin Cements to Zirconium Oxide Ceramic with and without Air-Particle Abrasion

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Clinical Oral Investigations 2010 (14:187–92)

ABSTRACT

Objective: This study evaluated shear bond strengths of six self-adhesive resin cements to a zirconia ceramic substrate with and without roughening of the surface by airborne-particle abrasion.

Materials and Methods: One hundred twenty square specimens (10 × 10 × 1 mm) of densely sintered Katana zirconia ceramic (Noritake, Naboya, Japan) were fabricated and randomly divided into two groups. In one group, the bonding surfaces were air-abraded with 50-μm alumina particles; specimens in the other group were left untreated. Composite cylinders were formed in plastic tubes and were bonded to the ceramic using a custom alignment apparatus and six self-adhesive resin cements. The cements were BisCem (Bisco, Inc., Schaumburg, IL, USA), Maxcem, G-Cem, RelyX Unicem Clicker, RelyX Unicem Aplicap, and Clearfil SA (Kuraray). After bonding, specimens were thermocycled 20,000 times between 5° and 60°C. Shear bond strengths were determined using an Instron (Canton, MA, USA) universal testing machine. Failure modes were evaluated using optical microscopy at 25× magnification.

Results: Without air-abrasion, mean shear bond strengths ranged from 0.3 MPa for BisCem to 7.9 MPa for G-Cem. With air-abrasion, the mean shear bond strengths increased into a range of 2.8 MPa and 22.4 MPa for those same two materials. Two versions of RelyX Unicem were tested. The mean bond strengths for the Aplicap version with and without air-abrasion were 8.0 and 14.6 MPa, respectively. The corresponding values for the Clicker version were 0.6 and 8.2 MPa.

Conclusions: Bond strengths of self-adhesive resin cements were increased by airborne-particle abrasion. Cements containing adhesive monomers were superior to other compositions.

COMMENTARY

The authors note the superiority of self-adhesive resin cements containing specific adhesive monomers: MDP in Clearfil SA and 4-META in G-Cem. Both monomers have exhibited excellent performance in adhesives and cements in laboratory and clinical studies.

The most popular and most widely studied self-adhesive resin cement is RelyX Unicem. It is worth noting that its original powder/liquid version (Aplicap) had higher bond strengths than its later paste/paste version (Clicker). A similar finding has been reported previously for different versions of a resin-modified glass ionomer cement. Despite this, many clinicians choose to use the paste/paste version for consistency and convenience of mix—or simply because they do not use amalgam and therefore do not have triturators in their practice. This study did not evaluate the newest "automix" version of RelyX Unicem (called Unicem 2).

Air-abrasion has been considered a somewhat controversial method for treatment of zirconia for resin bonding, on the assumption that it could create flaws leading to failure. However, no problems have been reported clinically, and judicious air-abrasion using small particles and relatively low pressures appears to be not just acceptable, but desirable when using self-adhesive resin cements with zirconia ceramics. Silicoating techniques (Rocatec and CoJet, 3M ESPE) are also effective.

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The Effect of Curing Mode on Extent of Polymerization and Microhardness of Dual-Cured, Self-Adhesive Resin Cements

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American Journal of Dentistry 2010 (23:14–8)

ABSTRACT

Objective: The purpose of this study was to evaluate the extent of polymerization and microhardness of dual-cure self-adhesive resin cements in their light-cure and self-cure modes.

Materials and Methods: Maxcem and RelyX Unicem were the self-adhesive cements tested in this study, and Panavia F2.0 was used as a control. Differential scanning calorimetry (DSC) was used to measure the extent of polymerization (or degree of conversion) of the three cements under two different curing conditions. Specimens of each material were either light-activated for 20 seconds using a halogen curing device and then allowed to self-cure for 2 hours or specimens were not exposed to the curing light and were only allowed to self-cure. In addition to the DSC, Vickers microhardness testing was performed.

Results: For all three materials, degree of conversion (DC) was better when they were light-activated. Expressed as percentages, the DC values for light-activated and self-cure specimens were 54.6 versus 40.5 for Maxcem, 54.4 versus 31.7 for RelyX Unicem, and 48.6 versus 31.4 for Panavia F2.0 (Kuraray). Vickers microhardness values followed a similar pattern. For example, the mean Vickers Hardness Number (VHN) for light-activated Unicem was 44; for self-cure only, it was 26.

Conclusions: Polymerization of dual-cure self-adhesive resin cements was similar to that of a conventional dual-cure resin cement control.

COMMENTARY

Given the data generated in this study, the authors' conclusion is an obvious one—but perhaps not particularly clinically relevant. The physical properties of any dental resin depend on conversion of monomer to polymer. So if lack of light activation decreases monomer conversion of these resin cements by 25 to 40%, as the results indicate, should clinicians be concerned? In fact, there is no clinical evidence that this reduced conversion is a problem for these materials. The self-adhesive resin cements have been widely used in situations where light activation is impossible or nearly so, e.g., in PFM or zirconia crowns. That said, they should be light-activated whenever possible to maximize their cure and physical properties.

 DOI 10.1111/j.1708-8240.2012.00521.x

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