Adhesive systems for resin-based luting agents: The promise and the problems

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Abstract
The use of resin-based luting agents is ever expanding with the development of adhesive dentistry. A multitude of different adhesive systems are used with resin based luting agents, and new products are introduced to the market frequently. Traditional adhesives generally required a multiple step bonding procedure prior to cementing with active resin-based luting materials; however, combined agents offer a simple application procedure. Self-etching ‘all-in-one’ systems claim that there is no need for the use of a separate adhesive process. This review focuses on the various adhesive systems used with resin-based luting cements.

Key words: Bonding, resin cement, hybrid layer, self adhesive cement.

Introduction:
Today, dentistry is rapidly moving from cementation of alloy-based restorations with traditional cements (e.g., glass-ionomer, resin-modified glass-ionomer, zinc phosphate, zinc polycarboxylate) to bonding of all ceramic restorations with resin based cements. With the increasing demand for high-end esthetic treatments for anterior teeth restorations, the need for a good esthetic cementation system comes into play in modern day dentistry. Resin cements have become popular, primarily because they have addressed the disadvantages of solubility, lack of adhesion, compressive strength and microleakage in some classes of luting agents and their ability to bond to both the tooth structure and restoration[1]. The adhesive luting technique consists of adhesive system application before the use of resin cement.

Definition of dental bonding systems & classification:
Dental bonding systems are resin blends possessing both hydrophilic and hydrophobic properties. The adhesive system plays an important role, providing a chemical bond between the cement and the substrate to be cemented. Despite their different formulations, all adhesives systems contain three cardinal steps which are considered pivotal to establishing a durable adhesive interface: 1) etching, 2) primer, 3) bonding[2].

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The etchant is an acidic solution that demineralizes the enamel/dentin surface, removes the smear layer and exposes a collagen network. The primer is composed of a mixture of hydrophilic monomers that infiltrates the collagen mesh. The bonding contains the hydrophobic part of the system that allows the coupling with the resin based restorative materials or the resin cements.

Adhesive systems interact with the dentin tissue following two different strategies: they can either remove the smear layer (etch-and-rinse technique) or maintain it as the substrate for the bonding (self-etch technique).

The etch-and-rinse strategy is characterized by the application of a preliminary and separate etching step (usually a gel of 35% phosphoric acid) that is later rinsed away. Conversely the self-etch approach refers to the application of an etching/primer solution that is only air-dried (no rinsing), additionally named “etch-and-dry”. The other cardinal steps such as priming and bonding can be separate or combined, depending on the adhesive formulation. If the bonding is combined with the primer (for the etch-and-rinse technique) or with the self-etching/primer agent (for the self-etch technique) the adhesives are considered as “simplified”.

As all adhesives contain etching, primer and bonding within their formulation, these are classified on the basis of the number and combination of the steps\[3\].

1. Etch-and-rinse adhesives
2. Self-etching adhesives

1. **Etch-and-rinse adhesives**

These systems use ‘total-etching’ (i.e. the simultaneous etching of enamel and dentin that dissolves the smear layers and smear plugs) with 35-40% phosphoric acid, rinsing of the etchant to remove smear layers, followed by the application of a primer and an adhesive (in one or two different solutions).

**Etch-and-rinse three-step:** Adhesive systems characterized by the sequential application of etching, primer and bonding as separate and individual solutions. Bonding to enamel is best accomplished with this system but the multi-step application technique is complex, and consequently may compromise bonding effectiveness to dentine\[4\].

**Etch-and-rinse two-step:** Simplified adhesive systems characterized by the use of a combined primer & bonding agent that is applied onto the tooth surface after the etchant is rinsed away from the tooth surface. These adhesives perform clinically less favorably than conventional three-step etch and rinse adhesives\[2,5\] e.g., Prime & Bond NT Dual-Cure + Calibra; XP BOND SCA + Calibra; Adper Single bond + RelyX-ARC; Excite + Variolink II; ED Primer + Panavia F 2.0.

With these systems problems with bonding may arise if there is inadequate penetration of the primer and bonding agent due to deep demineralization, collagen collapse from desiccation, or an over wet substrate.

2. **Self-etching systems:**

To reduce the number of operative steps and to simplify the clinical procedures, self-etching adhesive systems which do not
require a separate acid-etching step, have been developed\textsuperscript{[6]}. With these systems, an acidic primer partially dissolves the smear layer and hydroxyapatite crystals, thereby creating a hybrid layer that incorporates crystals and smear layer.

The bond strengths and other mechanical properties of some self-etching/self-adhesive systems approach those of the etch-and-rinse systems in dentin. The self-etching products may have the priming and bonding steps combined (1-step systems) or they may require an additional step (2-step adhesives).

**Self-etch two-step:** Adhesive systems characterized by a self-etching primer (etching and priming steps together) that is dried on the tooth surface, followed by a separate hydrophobic bonding agent e.g., AdhesSE Dual Cure + Variolink II.

The problem of technique sensitivity with etch-and-rinse adhesives also seems to have been significantly reduced with these systems which are attributed to the fact that the self-etching priming agent does not have to be washed off the dentin, therefore eliminating the need to maintain the dentin in a moist state.

**Self-etch one-step:** (One-bottle systems, All-in-one): Simplified adhesive systems characterized by the combination in a single application solution of the etchant & primer & bonding\textsuperscript{[7]}. Simplified adhesive systems are becoming more popular because of their simplicity and rapid application. However, the composition of these simplified versions is significantly modified, with greater quantities of acidic monomers, diluents and water. With these new formulations, the adhesive agents are more hydrophilic and therefore more susceptible to water sorption, which leads to hydrolytic degradation. These materials are not recommended for use with resin luting cements.

**Self-adhesive cements**

Recently, so-called universal, all-purpose or multipurpose, self-adhesive resin cements are commercially available. These adhesive cements no longer require pre-treatment of both tooth and restoration (no separate etch, prime and bonding stages) and could be used in one single application\textsuperscript{[7]}. For these systems, their resin matrix consists of multifunctional acid methacrylates that purportedly bond to a multitude of substrates such as enamel, dentin, amalgam, metal, and porcelain\textsuperscript{[8]} and produces a bond between the restoration and tooth structure comparable to that achieved by multi-step adhesive technologies. These cements have been proposed for luting zirconium-based restorations\textsuperscript{[9]}. Self-etching luting agents, by eliminating the need for a separate adhesive claims of favorable physical and bonding properties in vitro\textsuperscript{[10]}, low post-operative sensitivity, low de-bond rates, and ease of manipulation / handling. Self-etch adhesive cements have been found to have a low sensitivity with regard to the conditions of the dentin surface (dry, wet, or moist). Their bond strength is improved by separate etching of enamel, and they should always be applied with some pressure, to ensure adequate contact with dentin, e.g., RelyX Unicem Self-adhesive universal resin cement (3M ESPE), Monocem (Shofu) and Maxcem (Kerr).

**Conclusion:**

The luting of indirect dental restorations is a critical step in determining their success. There are many options to choose from when deciding what type of luting agent to use. The newest options include the so-
called “universal” self-etching/self-adhesive resin luting agents, which claim to be suitable for all types of indirect restorations (metal, composite, and porcelain inlays, onlays, crowns, bridges and endodontic posts), except for veneers, without the need for additional enamel/dentin adhesives. These newer self-etching/self-adhesive resin luting agents combines the easy handling of glass ionomer luting cements, requiring no pre-treatment of tooth structure, with the increased mechanical properties of traditional resin luting agents and less technique-sensitivity than their multiple step counterparts. It is a novel luting cement that addresses the complex needs of a variety of prosthodontic restorative material but long-term clinical performance of these materials needs to be assessed prior to making a general recommendation for their use.

References:


