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CEMENTATION PROCEDURES

Cementation Simplification: Taking the Mystery Out of Doing Things Correctly

David S. Hornbrook, DDS

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Cementation Simplification: Taking the Mystery Out of Doing Things Correctly

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Cementation Simplification: Taking the Mystery Out of Doing Things Correctly

David S. Hornbrook, DDS

ABSTRACT

There is more than one option to predictably cement an indirect restoration. Although adhesive cementation is the preferred method, often, due to difficulty is isolation, luting a restoration is preferable to adhesive bonding. This is especially true if the restoration is a high-strength ceramic or metal-supported and the preparation has adequate retention. This article reviews the types of materials available and provides recommended cementation protocols for different restorations.

LEARNING OBJECTIVES

- Discuss the ideal adhesive cementation protocol for anterior all-ceramic crowns and veneers.
- Review how dentinal adhesive agents have changed to reduce sensitivity and maximize predictability.
- Review how to achieve optimal adhesion for various restorative materials.
- Describe cementation options for posterior teeth, including adhesive bonding and the new bioactive luting cements.

Before the early 1950s, amalgam and silicate cement were used for dental procedures. Their popularity decreased throughout the years as patients communicated to their dental providers that they wanted their restorations to match the color of their teeth and look more natural. Michael Buonocore, DDS, responded to these concerns by bringing to the forefront the technique of acid etching the enamel, which increased retention of tooth-colored resin to tooth structure and provided a more natural look. For more than 60 years, resin bonding to the enamel has been standard practice, and for more than 30 years, adhesive bonding to dentin has shown to be predictable and has yielded the use of more conservative restoring and less destruction of tooth structure.[1]

As with many facets of dentistry, technologic advances have occurred in cementation, increasing the number of options available. After the development of the total-etch bonding agent in the 1990s, self-etching was developed in the 2000s, introducing even more options and reducing the technique sensitivity of the total-etch materials.[2] The options allow dentists to choose their materials and procedure based on the actual tooth or teeth being restored, the type of restoration, preparation design, and ease of use. Although there are benefits to having numerous options, they have created confusion among dental professionals. As the options of cementation materials offered by dental manufacturers continue to expand, it is important to understand which materials work best for certain circumstances. Therefore, understanding and simplifying the cementation process is necessary.

This report will detail three types of cement categories (adhesive cement; self-adhesive cement; and traditional cements, which include zinc phosphate, zinc polycarboxylate, resin-modified glass-ionomers, and glass-ionomers); three different dental adhesive systems (total etching, self-etching, and universal adhesive systems); and the adhesive bonding of veneers, crowns, and low-retentive preparations. The report will outline the advantages and disadvantages of each cement and system and the situations for which

they are recommended. Today's cements have the added advantage of offering more translucency, and when coupled with translucent ceramics, they offer the patient a more natural result. Dental professionals should understand and arm themselves with the information necessary to empower them to make informed decisions when cementing. The more informed the dentist is, the more prepared he or she will be in communicating the options to the patient.

TYPES OF CEMENTS

It is important to use the best type of cement depending on the circumstance. The advantages and disadvantages of each type of cement and procedure must be considered.

Adhesive Cements

Adhesive cementation is one option. Although the adhesive cement itself is a resin, to be used correctly it must be combined with an adhesive agent that enables it to bond with the dentin and enamel. This combination of an adhesive agent and a resin cement is highly retentive and has the best physical properties, including water solubility, compressive strength, and film thickness. However, it requires an increased number of steps. Ideally, an acid is applied to the tooth, followed by the adhesive agent, which is then air-dried and light polymerized before the cement is even placed on the restoration. This must all be performed while achieving isolation and eliminating saliva contamination. After the adhesive agent is light polymerized, the cement is mixed and applied to the intaglio surface of the restoration, and then the restoration is placed. Because of these additional steps combined with the need to adequately isolate, adhesive cementation is a technique-sensitive option and is therefore not always recommended or desirable for certain situations. Examples include locations where a rubber dam or other isolating device cannot be placed, such as a second molar, or if the patient has a large tongue compared with the size of the mouth or produces an excessive amount of saliva.

Adhesive cementation has proven to be the technique of choice for anterior all-ceramic veneers and crowns, especially with lower-strength ceramics. With the translucent ceramic materials, final shade can be altered by using different shaded cements, so many adhesive cementation systems include water-soluble try-in gels or pastes. Adhesive cements, due to their high bonds to tooth structure when coupled with dentinal adhesive systems, are necessary with low-retentive preparations. Another situation for which it is ideal to use adhesive cements is tooth-supporting restorations, such as ceramic inlays or onlays and bonded endodontic posts.[3]

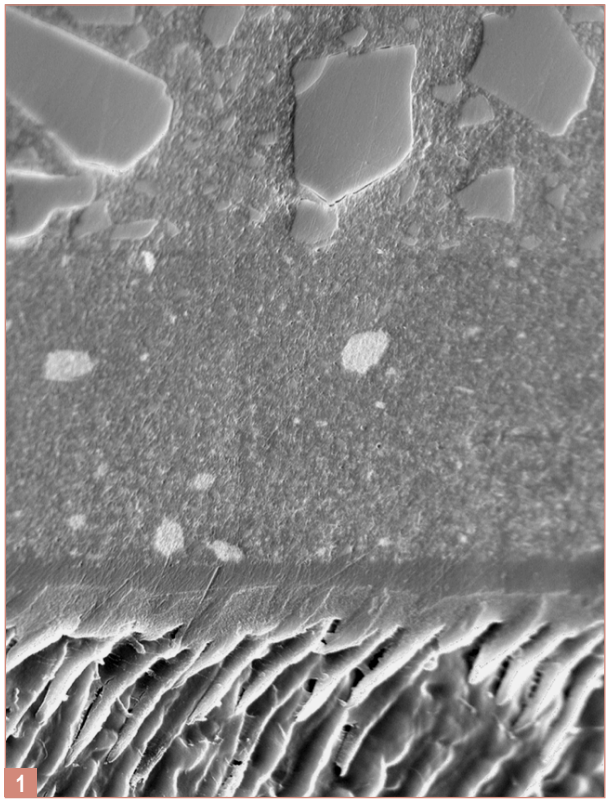
Self-Adhesive Cements

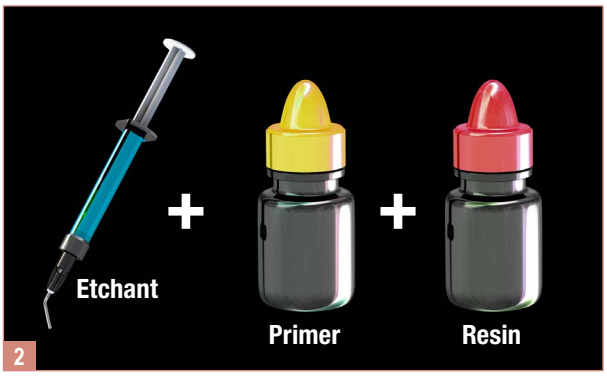
The second option to consider is the self-adhesive cement. There are many benefits to traditional self-adhesive cements, including relatively good bond strength, compatibility with various materials, minimal postoperative sensitivity, and fewer steps needed than with adhesive cements, thus making self-adhesives easier to use.[4] Self-adhesive cements bond to dentin and enamel as well as the restorative material, but the bond may dissipate over time because these cements are hydrophilic and can be affected by surface moisture.

Although the self-adhesive method does not necessarily result in a highly adhesive or retentive bond, its ease of use and ability to be used with a variety of materials make it a desirable option for cast-alloy crowns and bridges, ceramometal crowns and bridges, and high-strength ceramic crowns and bridges.[5] Dental professionals who are using self-adhesive cements must be sure to pick the correct kind for their needs because each type and brand responds differently.

Traditional Cements

The third cementation option is traditional cement. Traditional cements include zinc phosphate, zinc polycarboxylate, resin-modified glass-ionomers, and glass-ionomers.





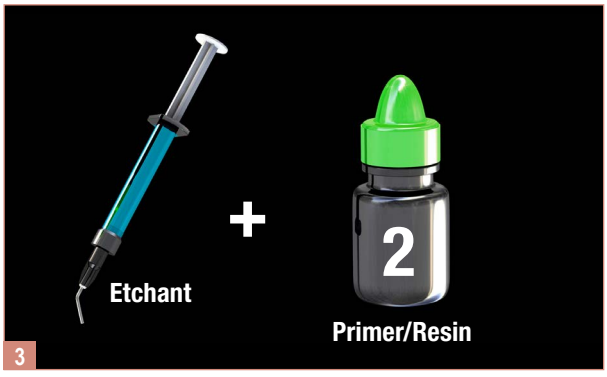


Fig 1. Hybrid layer at bottom, with resin layer above, topped by restorative resin. Fig 2. Three-step total-etching approach: etching, priming, and then bonding. Fig 3. Two-step total-etching approach: etching, followed by priming and bonding together.

Zinc phosphate, one of the first permanent cements, had many uses, including cementation of crowns, orthodontic appliances, cast inlays, metal post systems, and fixed partial dentures. Although it has moderate strength and acceptable film thickness, it has a low pH, which can contribute to pulpal irritation.[6] Unlike zinc phosphate, zinc polycarboxylate has less pulpal irritation; however, its short working time, low adhesion, and film thickness have decreased its use with the advent of superior, easy-to-use products.

Resin-modified ionomers and glass-ionomers are best when they are used for metallic and porcelain-fused-to-metal (PFM) restoration. With their fluoride release, they can add necessary minerals to a demineralized tooth structure, thus potentially combatting recurrent caries. These cements can be used with zirconia- and alumina-based ceramics, as long as there is adequate retention of the preparation.[7]

DENTAL ADHESIVE SYSTEMS

When bonding dentin and enamel, creating a strong hybrid layer is of primary importance. The purpose of etching the enamel with acid is to increase surface and provide mechanical retention. Etching of the dentin, when used, is designed to remove the smear layer, open the dentinal tubules, and create an environment in which application of an adhesive monomer can form a hybrid zone.[8] Typically a phosphoric acid is used on the dentin, which will remove the inorganic matrix on the dentin, leaving the collagen fibrils. A hydrophilic primer is applied to this demineralized dentinal surface, which infiltrates the collagen fibrils and polymerizes to form the hybrid layer, which is part tooth and part resin.[9] Complete hybridization of the demineralized dentin is essential; an incomplete layer can contribute to tooth sensitivity, microleakage, debonding, or fracturing from lack of underlying support.[10] To complete the adhesive process, a

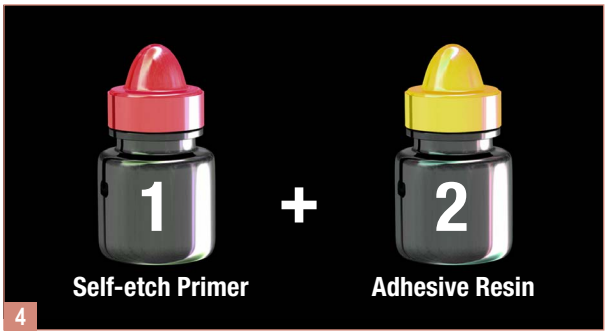


Fig 4. Two-step self-etching approach: primer and bonding resin in separate bottles.

Fig 5. One-step self-etching approach: etchant, primer, and adhesive in a single bottle.

hydrophobic resin is applied on top of the hybrid layer, which is then light-cured and finished with a restorative resin, either a resin cement or a direct composite resin (Figure 1).

Total Etching

One adhesive-system option is the total-etching approach. A 35% to 37% phosphoric acid gel is used to prepare the enamel and dentin for adhesion. Total etching can be a three-step or two-step procedure. The three-step approach includes etching, priming, and bonding (Figure 2), while the two-step approach begins with etching and then includes priming and bonding in a single coat (Figure 3). The total-etching procedure modifies the enamel and removes the smear layer. The benefit of this technique is that it creates the highest bond strength, the best durability, and the longest clinical success. Additionally, it does not interfere with polymerization of dual-cure resin products.

Total etching also has risks because it is a difficult technique to utilize. One must adequately etch the enamel, taking care not to over-etch the dentin, which can present a challenge. Although enamel requires 20 to 30 seconds of exposure to phosphoric acid gel, dentin must not be exposed for more than 15 seconds. The result of over-etching can be sensitivity and a decrease in bond strength caused by over-demineralization and the inability for complete hybrid layer formation.

The three-step approach is ideal for indirect restorations.[11] The two-step approach should only be used for direct restorations or indirect restorations where light can be used for polymerization, such as veneers, anterior all-ceramic crowns, or ceramic inlays and onlays. If light cannot penetrate through the restorative material, the bond can be compromised using a two-step adhesive. The two-step systems typically have a very low pH as they polymerize, and thus a self-cure or dual-cure resin cement will not adequately polymerize against this adhesive surface. This can especially be a problem with the new high-strength opaque ceramics or ceramics that are too thick to allow adequate light to penetrate to this cement/adhesive interface. The three-step systems, after polymerization and hybrid formation, result in a neutral pH surface that does not create a problem with the dual- and self-cure resin polymerization. Although the three-step technique is the most involved approach, it remains the most reliable and creates the strongest bond when done correctly.[12]

Self-Etching

Another adhesive system is self-etching, which was initially developed to combat tooth sensitivity issues that can result from total etching and incomplete hybridization. As with the total-etch adhesive systems, there are two self-etching techniques: a two-step and one-step approach. The difference is that the two-step approach keeps the primer and bonding resin in separate bottles (Figure 4), whereas the one-step approach

Fig 6. Lithium disilicate cleaned with phosphoric acid on left; zirconia cleaned with sodium hydroxide on right.

combines the etchant, primer, and adhesive in one bottle (Figure 5). Although there are two different approaches, studies have shown that each results in similar bond strength.[13] However, the dentist should be aware that the one-step approach may lead to compromised bond strength due to the increase in acidic monomer concentration.[14]

Self-etching has several potential benefits over total-etch systems. First, the conditioning, rinsing, and drying steps involved in total etching are no longer necessary, reducing the technique sensitivity. Also, there is reported significantly reduced postoperative sensitivity because the dentinal tubules are not opened during the process and collapse of the collagen network is prevented. Additionally, because the smear layer is not removed before bonding, one does not need to rewet dentin.[15] However, there are some disadvantages to self-etching because of high standard deviations associated with enamel adhesion. In preparations that are primarily into enamel only, it is prudent to utilize total etching.[16]

There appears to be a difference in perspective regarding the different etching techniques and their use by dental professionals. Although the dental academic world tends to support the total-etching technique because of its bonding strength, clinicians lean toward the self-etch technique due to ease of use and lack of tooth sensitivity.[1]

Universal

Some of the most recently developed adhesive systems are universal adhesive systems. Universal adhesive systems can be used for total etching, self-etching, or select etching.[17] Select etching involves etching only the enamel, as opposed to etching the entire tooth, enamel, and dentin. Both procedures require the rinse step.

BONDING VENEERS, ANTERIOR AND POSTERIOR CROWNS, AND LOW-RETENTIVE PREPARATIONS

To prepare a tooth for a restoration, one must first etch the enamel, followed by the dentin, unless one is select etching, in which case etching the dentin is not required. The next step is to rinse lightly and air-dry, taking caution to remove most of the excess moisture but making sure the area does not become completely dry. Next is application of a solution of 2-hydroxyethyl methacrylate (HEMA), water, and glutaraldehyde, for 10 to 15 seconds, and then blotting the excess moisture off the tooth using a foam pellet or brush. This solution will act both as a rewetting and antibacterial agent. It has shown to increase bond strength, reduce sensitivity, and kill bacteria.[18] If a self-etch system is used, the use of the antibacterial agent is most likely not necessary because the dentinal tubules are not opened during the etching process. If the clinician chooses to use a self-etching adhesive, the first bottle is used by agitating the acidic primer on both the enamel and dentin using a small brush tip. After the acidic primer is applied, it is air-dried aggressively.

With the total-etch system, the next step is to apply multiple coats of primer. If the total-etch three-step system is used, the primer will be in its own bottle. If the two-step total-etch system is used, the second component of that system will be applied to both the enamel and dentin. If using a universal adhesive system, the single-bottle primer will be applied on both the enamel and dentin, whether the enamel and dentin were

etched or not. The next step is to air-dry thoroughly. Regardless of the system being used, the next step is to light polymerize, making sure the hybrid layer is completely polymerized. Failing to do so could lead to the polymerization shrinkage of the overlying restorative or resin cement to overcome the bond to the tooth, which could ultimately compromise the bond and result in postoperative complications such as sensitivity, microleakage, or debonding of the restoration.[19]

Restoration preparation will vary based on the material being used (Figure 6). Restorations fabricated from lithium disilicate, lithium silicate, or feldspathic ceramic are etched in the dental laboratory using hydrofluoric acid. Although this creates a roughened surface, the restorations can become contaminated during try-in and should be cleaned internally with phosphoric acid. After applying the phosphoric acid to the surface with slight agitation using a brush, the restorations should be rinsed and thoroughly dried. This is then followed by the application of a silane coupling agent onto the internal surface, which is then allowed to remain undisturbed for 60 seconds. This surface should then be air-dried before the cement is applied.[20]

When using zirconium dioxide or metals, such as gold, there is a need to clean the potentially contaminated surface after try-in with alcohol or an alkaline-based product, such as a sodium hydroxide solution. It is extremely important to use an alkaline-based solution when cleaning metals and not use phosphoric acids. A zirconia or metal primer achieves chemical adhesion to the surface using phosphate groups that bind to receptor sites on the surface of the restorations. Phosphoric acid, when used as a cleaner, binds up these receptor sites and significantly diminishes the adhesion capabilities of the primer.[21]

After the tooth and restoration are properly prepared, the restorative cement is then chosen and applied to the internal aspect of the restoration. The preparation design and the material used are the two most important determinants of which type of cement should be used. For anterior veneers and crowns, light-cured resin cements are recommended because they allow more working time, provide water-soluble try-in gels, and involve relatively easy cleanup. For posterior crowns, adhesive cementation using a dual-cure resin cement is always preferred, especially with non-retentive preparations or with minimal occlusal thickness. Because many of these posterior crowns are too thick to allow adequate light penetration, using a dual-cure resin cement will provide complete polymerization under the restoration.[22]

Often, especially on mandibular second molars, complete isolation throughout the adhesive and cementation process is difficult. In these cases, if the preparation is retentive, a self-adhesive resin cement can be used. Although they are not as retentive as using a dentinal adhesive system followed by a true resin cement, the physical properties are adequate to be used as a definitive cement on these restorations and have superior physical properties as compared with zinc phosphate, polycarboxylate, glass-ionomers, and most resin-ionomer cements. When using a self-adhesive resin cement, etching and priming the tooth is not necessary because the cement itself has a primer built into it. After try-in, the internal of the restoration is prepared as explained above and then the preparation is cleaned using a pumice or by micro-etching with 50-µm aluminum oxide. Then self-etching resin is applied to the internal of the restoration, seated completely, and light polymerized. Mo st of these self-etching resin cements, when tacked into place using a small-diameter light guide and then having the margins "waved" with a larger light guide for 5 seconds, are easily removed with a scaler or explorer.

A new category of self-etching resin cements is an exciting addition to the restorative armamentarium. These new cements have bioactive properties and release fluoride, phosphate, and calcium into the enamel and dentin to counteract any acid demineralization that could

limit long-term success. The new cements are alkaline-based and preferably promote apatite formation and healing of pulp tissue, inhibit bacterial growth, and neutralize acidic bacterial by-products while preventing secondary caries.[23]

CONCLUSION

Technologic advancements and the increase in available options allow dental professionals to choose cementation systems that work best for their needs and skill set while also considering the dental needs of the patient. New developments have also allowed for more consistent and reliable results. Thanks to the advancements that have and will continue to be made, cementation is becoming a much simpler and more predictable process than it was a few decades ago.

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Cementation Simplification: Taking the Mystery Out of Doing Things Correctly

David S. Hornbrook, DDS

1. Today's cements have the added advantage of:
A. being exceptionally easy to use.
B. offering more translucency.
C. being as close to ideal as possible.
D. being calming to any exposed pulp.

2. Adhesive cement:
A. is a resin.
B. requires a single step only.
C. requires a two-step process only.
D. bonds equally to dentin and enamel.

3. Adhesive cements are:
A. necessary with low-retentive preparations.
B. ideal to use for tooth-supporting restorations.
C. ideal to use for bonded endodontic posts.
D. all of the above

4. Self-adhesive cements bond to dentin and enamel as well as the restorative material, but the bond may dissipate over time because these cements are:
A. thick.
B. thin.
C. hydrophilic.
D. hydrophobic.

5. Which traditional cement has a low pH?
A. zinc phosphate
B. zinc polycarboxylate
C. resin-modified glass-ionomer
D. glass-ionomer

6. When bonding dentin and enamel, creating what is of primary importance?
A. a hermetic seal
B. a strong hybrid layer
C. a cytotoxic zone
D. a zone of bacterial inhibition

7. Although enamel requires 20 to 30 seconds of exposure to phosphoric acid gel, dentin must not be exposed for more than:
A. 1 second.
B. 3 seconds.
C. 5 seconds.
D. 15 seconds.

8. Self-etching has several potential benefits, including:
A. eliminating the conditioning, rinsing, and drying steps.
B. reported significantly reduced postoperative sensitivity.
C. one does not need to rewet the dentin.
D. all of the above

9. Universal adhesive systems can be used for:
A. total etching.
B. self-etching.
C. select etching.
D. all of the above

10. To prepare a tooth for a restoration, one must first:
A. etch the enamel.
B. etch the dentin.
C. apply a solution of HEMA.
D. use an antibacterial agent.

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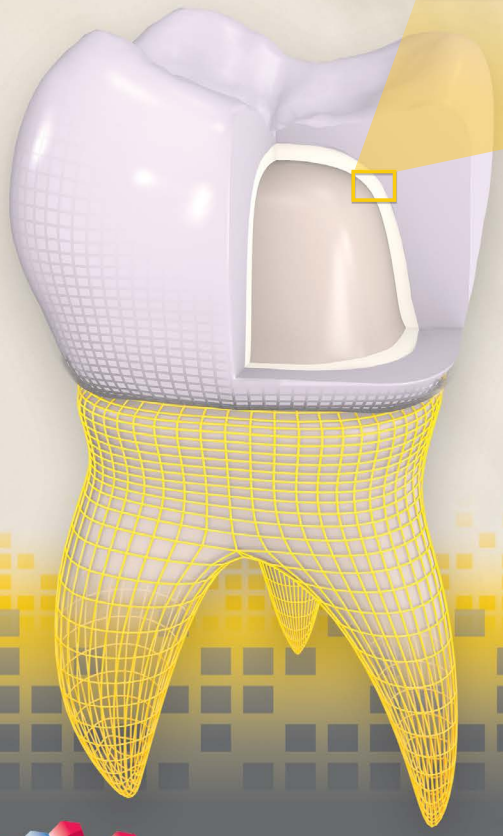

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Rx Only

MC-11149TC