Dental cements: an overview

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Most definitive indirect dental restorations today are luted to the preparations using one of 4 types of dental cements: (1) glass ionomer (GI) cements, (2) resin-modified glass ionomer (RGMI) cements, (3) self-etching resin cements, or (4) resin cements, requiring the use of total-etch technique and placement of dentin adhesives on the preparation prior to luting the definitive restoration.

First, it is important to note that no cement will perform to its optimal level clinically without an adequate preparation that includes good resistance and retention form. Total-etch adhesives and resin cements by virtue of higher bond strengths can help compensate for minor issues of exaggerated axial taper and/or lack of axial height of the preparation. However, no cement will hold a restoration in place long-term when the preparation is grossly inadequate. New metal and ceramic primers have been developed that have been reported to enhance bond strengths of cements to nonetchable substrates, such as zirconia and metal.[1]

Provisional cements

Before discussing definitive cementation, it is important to remember that provisional restorations must also be cemented to the preparations during the time between preparation and delivery of the definitive prosthetics. This timeframe may be anywhere from a few weeks to several months, depending upon the clinical situation that presents at the time of preparation. It is sometimes necessary to keep patients in long-term provisionalization when assessing pulpal health, waiting for gingival healing from periodontal and oral surgery, waiting for implants to integrate, and evaluating aesthetic and functional changes, to name a few. Some of the clinical requirements of provisional cements are: (1) good retention – it is desirable to have enough retention for long-term provisional cementation, yet not be so retentive that is difficult to remove the restoration as needed during treatment, (2) good marginal seal to prevent microleakage and recurrent decay during the provisional phase of treatment, (3) durability, to prevent "wash out" and resulting sensitivity issues, and (4) ease of cleanup from the inside and outside surfaces of the provisional restoration, as well as the preparation surface.[2]

Glass ionomer and resin-modified cements

GI cement has been an excellent performer for many years, and this category of cements is used primarily in the cementation of metallic and PFM restorations. GI cement has a very thin film thickness, is extremely moisture tolerant, and due to fluoride release, can have a remineralization effect with demineralized tooth structure. RMGI cements were made to create an insoluble version of GI for cementation. The clinical benefit of a RMGI cement is that it has many benefits of the GI cement, but is insoluble in the oral fluids. RMGI cement is used primarily for the cementation of metallic and PFM restorations; particularly in clinical situations where moisture control is difficult. This type of cement has also been successfully used with zirconia- and alumina-based ceramics as well as lithium disilicate pressed and milled (CAD/CAM) inlays and onlays.[3-8]

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Resin cements: total-etch and self-etch systems

Resin cements evolved from total-etch and self-etch dentin adhesive technologies. For proper use, pure resin cements require pretreatment of the tooth surface with 37% phosphoric acid and application of a dentin bonding agent prior to application of the resin cement. These cements truly form a micromechanical bond to both tooth structure on one side and restorative material on the other side. Also, they are insoluble in oral fluids. There are 2 types of these "traditional resin cements" (those that require the use of the "totaletch technique and dentin adhesive technology") that are commonly used – dual-cured and light-cured versions. It is recommended by most manufacturers and clinicians to place etchable, partial-coverage, all-ceramic restorations, such as porcelain veneers, using the total-etch technique and resin cement only! The most recent addition to the "resin cement family" are the self-etching resin cements that require no pretreatment of the tooth surface and appear to have many of the clinical advantages of traditional resin cement systems, with the ease of use of more traditional types of cements. Many types of restorative materials can be successfully cemented using selfetching resin cements, including metallic (gold) crowns, inlays, and onlays; milled and pressed all-ceramic crowns, inlays, and onlays, (including leucite-reinforced, lithium disilicate, alumina- and zirconia-based full-coverage restorations); and PFM crowns. It is important to note that, in general, bond strengths of self-etching resin cements are not as high as those for resin cements using the total-etch technique. However, it is important to remember that the purpose of any cement is to fill the microgap between tooth structure and restorative material, and to assist in the retention of the restoration. Again, proper resistance and retention form of the preparation is still more important for successful retention of any restorative material than the cement that is used for placement. With regard to delivery systems for self-etching resin cements, the first cements in this category were packaged in capsules and required trituration (to initiate the reaction of the components and to activate the setting process). Many of these cements are now available using automix delivery systems, greatly simplifying their use by eliminating the need for a triturator in the operatory.[9-13]

Choices of dental cements: which one for which clinical situation?

It is the opinion of the author that in a "perfect" clinical world, all restorative margins should be supragingival. In addition, total-etch and resin cement is the technique and material of choice for definitive cementation, offering the most optimal result as far as seal and retention of the restoration. But, this is not "real life" dentistry. Other factors, such as restorative material and clinical environment affect the cement choice in many cases. The ability to clinically isolate the operative area from contamination due to the presence of blood and other oral fluids is absolutely essential for successful use of total-etch resin cement systems. Preparations with less than ideal cervicoincisal height may require that additional bond strength that is afforded by the use of total-etch resin cements. Lastly, there are some dental materials that cannot be cemented without the use of total-etch resin cement techniques due to the nature of the all-ceramic material; for example, feldspathic porcelain laminate veneers.

RMGI cements are excellent to use when moisture control is a problem. Restorations with intracrevicular margins in molar regions where crevicular fluids, salivary flow, and/or tongue control can present clinical challenges to the dentist in maintaining a dry operating field are good places to consider using an RMGI cement. Also, in the definitive cementation of implant restorations, because of extremely low film thickness, RMGI cement can be "painted" very sparingly on the internal surface of the restoration. Using this technique helps to eliminate the hydraulic issues associated with placement because of the precision of the fit of the restoration to the abutment.

Clinical Case 1

Provisional Cementation Technique

The patient shown in Figure 1 had very short clinical crowns on teeth Nos. 7 to 10 due to years of wear and the lack of anterior guidance. Since the sulcular depth on the facial aspect of these teeth was 3.0 mm, we were able to do a soft-tissue crown lengthening procedure using a diode laser (NV Laser [Philips Discus Dental]) to gain 2.0 mm of clinical crown length in the cervico-incisal direction (Figure 2). As long as 1.0 mm of gingival sulcus remained after the laser gingivectomy, the biologic width would not be violated. The

teeth were then prepared for full-coverage lithium disilicate (e.max [Ivoclar Vivadent]) crowns (Figure 3). The provisional restoration (Figure 4) was fabricated out of a rubberized urethane provisional material (Tuff Temp [Pulpdent]) to provide additional strength due to the aggressive wear that existed preoperatively. Although the provisional restoration was splinted, the definitive restorations would be individual crowns. A GI provisional cement (Fuji Temp LT [GC America]) was then used to lute the provisional restoration into place. (Fuji Temp LT is the first provisional GI cement on the market to offer the benefits of fluoride release, since it is a GI material.) The provisional

Figure 1: A preoperative view of teeth Nos. 7 to 10 ready to prepare for full-coverage restorations. Due to severe attrition over time, the goal was to add length back to these teeth in both the incisal and gingival directions.

Figure 2: Gingival surgery was performed using a diode laser (NV Laser [Philips Discus Dental]) to create a gingival zenith above the central incisors at the distolabial line angles, at a level slightly apical to the gingival crest above the lateral incisors.

Figure 3: A retracted facial view of the preparations is completed following gingival zenith correction.

Figure 4: The completed provisional restoration for teeth Nos. 7 to 10, made from a rubberized urethane provisional material (Tuff Temp [Pulpdent]).

Figure 5: A glass ionomer (GI) provisional cement (Fuji Temp LT [GC America]) was extruded onto a mixing pad.

cement was expressed from the automix cartridge onto a mixing pad (Figure 5) then spatulated. Next, the provisional cement was placed into the individual units of the restoration using a plastic filling instrument (6). The restoration was then seated with finger pressure and held in place with constant pressure until the initial gel set was reached (Figure 7). Once the gel set was reached, an explorer (or scaler) was used to easily remove the excess cement from the marginal areas and from the provisional restoration

Figure 6: After spatulation, the GI provisional cement was placed into the provisional restoration using a plastic filling instrument.

Figure 7: The provisional restoration was then firmly placed on the preparations. (Note: Although the 4 teeth are splinted in the provisional restoration, they were all to be individual units in the definitive restorations.)

Figure 8: After the setting of the GI provisional cement, the excess at the margins was removed using an explorer. The cement has a "rubberized" consistency that makes it easy to peel away from the provisional material without smearing or sticking to the plastic.

Figure 9: The provisional restoration after cementation.

Figure 10: A "closed flap" crown lengthening on the distofacial aspect of the gingival zeniths of the central incisors is performed using an Er,Cr:YSGG all-tissue laser (BIOLASE Technologies) to reposition the bony crest 3 mm apical to the restorative margin.

(Figure 8). Figure 9 shows the provisional restorations after the excess cement had been easily cleaned up. The cement has a "rubberized" consistency that makes it easy to peel away from the provisional material without smearing or sticking to the plastic (common with zinc-oxide based provisional cements). The film thickness was thin enough to ensure complete seating, and the fluoride release helped to protect the underlying teeth from the negative effects of the perimarginal environment (bacteria) and to decrease dentin hypersensitivity while the patient was wearing the provisional restoration. The retention due to the GI cement's ability to bond to dentin is good, yet the cleanup of the preparations at definitive cementation is effortless. Figure 10 shows the preparations after cementation of the provisional restoration during a closed-flap crown lengthening procedure with an all-tissue laser to correct the crestal bone position as a result of the apical repositioning of the free gingival margin. The definitive restorations were then placed upon receipt from the dental laboratory team.

Clinical Case 2

Cementation of a PFM fixed partial denture using an resin-modified glass ionomer cement

The patient shown in Figure 11 underwent a segmental full-mouth rehabilitation, starting with the maxillary right quadrant. The teeth were prepared for a 5-unit PFM fixed partial denture (bridge). A decision was made to splint the teeth because the premolar teeth, while stable, had less than ideal crown-to-root ratios. (This decision was made in conjunction with the periodontal specialist to use the cuspid and multirooted second molar to stabilize the quadrant at this time.) Tooth No. 4 had a history of endodontic treatment with a metallic post and core, so the decision was made to make a conventional PFM for this case. It was also clear (Figure 11) that moisture and tongue control in the molar region would be a challenge. Therefore, the definitive cement chosen for this situation was an RMGI cement (FujiCEM [GC America]) (Figure 12). Prior to cementation, the teeth were cleaned and disinfected using a dentin desensitizer (AcquaSeal B [AcquaMed Technologies]) (Figure 13). It is important to remember that when using an RMGI cement, not to over dry and desiccate the preparations prior to the cementation process. This will lead to the potential for postoperative dentin hypersensitivity. The preparations can be dried using a cotton pledget so that a small amount of moisture remains on the surface. The set reaction of RMGI cement actually depends on a small amount of moisture for optimal setting of the material. Figure 14 demonstrates the convenience of the automix paste-paste delivery as the RMGI cement was placed directly into the restoration. It is

Figure 11: A precementation view of the maxillary right quadrant. A five-unit PFM bridge is about to be cemented to place using a resin-modified glass ionomer (RMGI) cement (FujiCEM [GC America]).

Figure 12: FujiCEM in a paste-paste automix delivery system is shown in this photograph.

Figure 13: The preparations were first disinfected and treated with a dentin desensitizer (AcquaSeal B [AcquaMed Technologies]) using a cotton pledget.

Figure 14: An RMGI cement (FujiCEM) was extruded from the cartridge with mixing tip directly into the abutments of the restoration.

Figure 15: The restoration was firmly seated with finger pressure, extruding the excess cement around the margins of the abutment teeth. This was easily accomplished due to the thin film thickness (6 μm) of the RMGI cement.

Figure 16: After holding the restoration with firm finger pressure for 30 to 45 seconds, and while the cement had still not reached a set, the patient was asked to close firmly on the restoration to ensure complete seat.

preferable to adequately fill the inner aspects of the restoration and extrude the excess upon seating. The low-film thickness of the RMGI cement allowed for a complete seating of the restoration. Finger pressure was used for several seconds (Figure 15) to extrude excess cement around the margins of the restoration. The patient was then asked to bite carefully into maximum intercuspation and "squeeze" the teeth together to further aid in the seating of the bridge (Figure 16). After holding the teeth tightly together for about 10 seconds, the patient was asked to open. A cotton roll was placed between the teeth on both sides of the mouth in the posterior area and the patient was asked to bite down and hold until the initial set was complete (Figure 17). Once the initial set is complete, the excess cement could be cleaned out with an explorer or scaler (Figure 18). A sonic or piezo scaler with water spray can also be used carefully to ensure complete cement removal from the sulcular areas. Figure 19 shows the 5-unit bridge after definitive cementation using RMGI cement (FujiCEM).

Figure 17: After confirming complete seat with a full closure of the mandible into maximum intercuspation, cotton rolls were then placed bilaterally in the posterior areas and the patient was asked to close tightly. This holds the restoration firmly and undisturbed until initial set of the cement is reached.

Figure 18: After complete set, the excess RMGI cement around the margins of the restoration was easily removed using an explorer.

Figure 19: A retracted facial view of the cemented PFM fixed partial denture (bridge).

Clinical Case 3

Cementation of single-unit all-ceramic crowns using a self-etching resin cement

Figures 20 and 21 show lingual and facial views of all-ceramic restorations for teeth Nos. 8 and 9, ready for delivery. The provisional restorations were removed and the all-ceramic crowns were tried-in individually to evaluate fit at the margins and the proximal fit. The preparations were then cleaned and disinfected using a desensitizer on a cotton pellet, which contains water and an antimicrobial agent (AcquaSeal B). A new product, Z-Prime Plus (Bisco), was painted on the internal surfaces. This surface treatment agent has been shown to help create a stronger bond between the resin cement and the zirconium surface when applied to the internal surface of the restoration prior to cementation.

After proper isolation was achieved (Isolite [Isolite Technologies]), the restorations were ready for placement (Figure 22). The selfetching resin cement (G-CEM [GC America]) was triturated and dispensed from the mixed capsule directly into the inner surface of the restorations (Figure 23). (G-CEM is now available in an easy-to-use automix syringe delivery system as well (Figure 24). The right maxillary central incisor crown was placed onto the preparation, expressing the excess resin cement at the margins. Intermittent finger pressure was used to ensure that all the excess cement was expressed and the restoration was fully seated (Figure 25). A sable brush (Figure 26) was then used to remove the majority of the excess cement. However, care was taken not to disrupt the seat position of the restoration by cleaning up the excess cement too aggressively! Next, we made sure the excess cement was completely removed from the proximal aspect adjacent to the other central incisor preparation. Then, the adjacent restoration was seated on the preparation (without cement) to hold the correct position of the cemented unit during the gel set. (Note: Finger pressure was maintained on the incisal edges of the restorations.) It is important that the initial set of the cement is not compromised by accidently rotating or unseating the restoration during this time. The self-etching mechanism of the cement depends on the restorations being immobilized during this time. If movement of the restoration occurs, the final bond strength will be compromised.

After the gel set was initiated, an explorer was carefully

Figure 20: The internal surfaces of the definitive zirconium maxillary central incisors (shown prior to cementation) were cleaned and then treated using a zirconium oxide primer (Z-Prime [Bisco]).

Figure 21: Facial view of the definitive restorations on the master model.

Figure 22: Retracted view of the preparations of teeth Nos. 8 and 9, prior to cementation.

Figure 23: Self-etching resin cement was applied to the internal surface of the restorations through the tip of the triturated capsule.

Figure 24: Self-etching resin cement (G-CEM [GC America]) with automix delivery.

Figure 25: After trying each restoration individually to evaluate marginal fit, then collectively to evaluate proximal fit, the maxillary right central incisor was pushed into place and held with finger pressure, undisturbed for at least 90 seconds to allow the self-etching chemistry to etch and bond to the tooth structure.

Figure 26: After 90 seconds and prior to the gel set, a sable brush was used to remove excess cement at the margins.

used to remove the last amounts of excess from around the margins of the restoration (Figures 27 and 28). Complete light-curing of the restoration was carried out. Next (and this process was done to definitively cement the adjacent restoration, dental tape was used interproximally to make sure all of the excess cement had been removed. Figure 29 shows both maxillary central incisor restorations after definitive cementation was completed.

Conclusion

Protocols have been presented for the use of commonly used dental cements for the definitive placement of indirect restorations. Following manufacturer's instructions is instrumental in maximizing clinical success, and following recommendations precisely will lead to predictable and reliable placement of many of today's dental restorative materials.

Figure 27: The restoration on tooth No. 8 is shown after the gel set and prior to removal of the marginal excess. While the cement sets, the restoration on tooth No. 9 was set on the preparation (without cement) to hold the crown No. 8 in its proper spatial orientation.

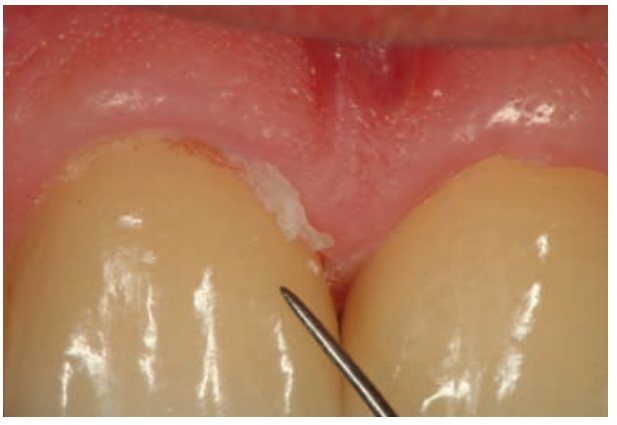

Figure 28: An explorer was used to remove any remaining excess cement away from the margins of the restorations. Dental floss was then used to clear any remaining cement from the proximal areas. Light-curing around the margins could then be done to accelerate the set time if desired.

Figure 29: The completed restorations on teeth Nos. 8 and 9.

References

1. Suh BI, Chen L, Brown DJ. Bonding to zirconia: innovation in adhesion. Compendium. 2010;31(suppl 1):2-7.
2. Kanakuri K, Kawamoto Y, Kakehashi Y, et al. Influence of temporary cements on bond strength between resin-based luting agents and dentin. Am J Dent. 2006;19:101-105.
3. Cardoso MV, Delmé KI, Mine A, et al. Towards a better understanding of the adhesion mechanism of resin-modified glassionomers by bonding to differently prepared dentin. J Dent. 2010;38:921-929.
4. Munhoz T, Karpukhina N, Hill RG, et al. Setting of commercial glass ionomer cement Fuji IX by (27)Al and (19)F MAS-NMR. J Dent. 2010;38:325-330.
5. Zhang W, Masumi SI, Song XM. Bonding property of two resin-reinforced glass-ionomer cements to zirconia ceramic. Quintessence Int. 2010;41:e132-e140.
6. Coutinho E, Cardoso MV, De Munck J, et al. Bonding effectiveness and interfacial characterization of a nano-filled resinmodified glass-ionomer. Dent Mater. 2009;25:1347-1357.
7. E L, Irie M, Nagaoka N, et al. Mechanical properties of a resin-modified glass ionomer cement for luting: effect of adding spherical silica filler. Dent Mater J. 2010;29:253-261.
8. Fagundes TC, Toledano M, Navarro MF, et al. Resistance to degradation of resin-modified glass-ionomer cements dentine bonds. J Dent. 2009;37:342-347.
9. Gordan VV, Mondragon E, Watson RE, et al. A clinical evaluation of a self-etching primer and a giomer restorative material: results at eight years. J Am Dent Assoc. 2007;138:621-627.
10. Weiner R. An advanced self-etching resin cement: clinical application. Dent Today. 2008;27:82,84.
11. Burgess JO, Ghuman T, Cakir D. Self-adhesive resin cements. J Esthet Restor Dent. 2010;22:412-419.
12. Capa N, Ozkurt Z, Canpolat C, et al. Shear bondstrength of luting agents to fixed prosthodontic restorative core materials. Aust Dent J. 2009;54:334-340.
13. Christensen GJ. Why use resin cements? J Am Dent Assoc. 2010;141:204-206.

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