Simplifying Cem entation of High-Strength Restorations:
Using an Improved Resin-Modified Glass Ionomer Cement

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**Simplifying Cementation of High-Strength Restorations:**
*Using an Improved Resin-Modified Glass Ionomer Cement Restorations*

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**INTRODUCTION**

All dentists who place indirect restorations must consider, as part of their restorative technique, which dental cement they will use. Selecting the most ideal material is difficult, as there are numerous cements from which to choose. Dental materials manufacturers are constantly introducing new or improved products. In 2005, a survey of dental schools in the United States and Canada was conducted to determine what these schools were teaching with respect to what type cement should be used in a specific situation. The author concluded that there was no agreement among the schools as to which material was appropriate for any given clinical scenario.¹

A recent paper by Hill and Lott² states that an indirect restoration must be sealed with a luting agent. They² go on to say that the primary function of a luting agent is to fill the minute void between the tooth preparation and restoration and to mechanically lock the restoration in place to prevent dislodgement during function.

Ideal properties of a dental cement include: biocompatibility, caries inhibition, reduction of microleakage, physical properties that resist functional forces, insolubility, absence of post-operative sensitivity, low film thickness, extended working and setting time, and ease of dispensing, mixing, and cleanup.³ Simon and Darnell⁴ add the following to the list: stable bond to the remaining tooth structure and the restoration material, radiopacity, color stability, and ease of use.

Dental cements can be classified by their chemistry. Resin, glass ionomer (GI), and resin-modified (or reinforced) glass ionomer (RMGI) are popular at this time. One article⁵ published in 2013, states that the RMGI cement is the most frequently used cement for the cementation of well-fitting PFM crowns, full cast crowns, and high-strength ceramic restorations. Christensen⁶ suggests that an RMGI is the cement of choice for routine cementation of PFM and zirconia-based restorations because of its desirable characteristics. In his 2004 column, Christensen⁷ states that when placing high-strength all-ceramics—also referred to as polycrystalline or metal oxide all-ceramics (alumina- or zirconia-based products such as Procera [Nobel Biocare], Lava [3M ESPE], etc)—a conventional RMGI cement works well.⁷ Due to the fact that RMGI materials can expand when exposed to moisture, it has been suggested that they should not be used with certain glass or leucite-reinforced all-ceramic restorations (such as IPS Empress or Empress Esthetic [Ivoclar Vivadent], or other restorative applications using conventional feldspathic porcelains).⁸ Yet, Christensen⁹ reports that long-term studies have shown the use of an RMGI cement to be sufficiently retentive for adequate tooth preparations specifically with respect to lithium disilicate (IPS e.max [Ivoclar Vivadent]) restorations. A 2004 survey¹⁰ indicated that more than half of all PFM crowns were cemented using an RMGI.

This paper will discuss GI and RMGI cements and will highlight a clinical case using FujiCEM 2 (GC America).

**Background: Glass Ionomer and Resin-Modified Glass Ionomer Cements**

GI was developed in the early 1970s. The first of 2 components is an acid soluble calcium fluoroaluminosilicate...
glass, and the second is aqueous solution of polyacrylic acid. When both components are mixed, an acid-base reaction occurs. The acid etches the surface of the glass particles, resulting in the release of calcium, aluminum, sodium, and flerovium. The overall pulpal biocompatibility of GI materials has been attributed to the weak nature of the polyacrylic acid. It is unable to diffuse through the dentin due to its high molecular weight.

An advantage of GIs is the ability of these materials to bond with the tooth. This adhesion occurs between the carboxyl groups of the polyacrylic acid and the calcium in the tooth via a hydrogen bond. Additionally, these materials have a low coefficient of thermal expansion similar to tooth structure (allowing them to maintain a bond to tooth structure), and allow for the release of fluoride to the surrounding tooth. The benefit of a low coefficient of thermal expansion is the reduction of microleakage and postoperative sensitivity. The fluoride release occurs early and tapers off after about 10 days. For better adhesion, the preparation surface should be cleaned with a slurry of pumice or with 10% polyacrylic acid, then dried but not dessicated.

Fluoride release from these products causes the formation of fluorohydroxyapatite in the adjacent tooth structure, therefore making the adjacent tooth structure more resistant to demineralization. It has been shown that the fluoride release does inhibit secondary caries and that fluoride is toxic to those microorganisms associated with caries. In fact, one study has shown that these materials have a greater antibacterial effect than does calcium hydroxide. Matalon et al showed that an RMGI exhibited potent antibacterial activity in a direct-contact antimicrobial assay against Streptococcus mutans.

The fluoride that leaches out can be replaced (or recharged). This should be done with a neutral fluoride versus an acidic one, which would dissolve the surface of the GI. There are several vehicles that can accomplish this: toothpaste, topical application, and gels. The fluoride gel is the most effective method. When a topical acidulated phosphate fluoride gel is used, the surface of the glass ionomer is damaged, and this damage may be the source of the increased fluoride release. Fluoride release from restorative materials can reduce caries, with no patient compliance required, and is important for controlling caries in higher caries risk patients.

The difference between GIs and RMGIs is that the RMGIs are additionally composed of water-soluble polymers or polymerizable resins. RMGIs were developed to overcome the high solubility of GI. These cements bond to the inorganic dentin via a link to calcium ions present in the dentin. As with GIs, this is an acid-base reaction that occurs in an aqueous environment. By combining the advantages of GI and resin, these materials also release fluoride, have an increased resistance to microleakage, adhere to tooth structure, and are less soluble than a conventional GI. These versions have a longer working time than do traditional GIs. Clinicians should be aware that after the photopolymerization of the RMGI is complete, the GI setting reaction continues. This is somewhat protected from moisture and overdrying by the hard resin framework.
Completion of the acid-base reaction helps decrease the solubility of these products. This makes this material more advantageous in a moist environment. Restorations with margins where crevicular fluids, salivary flow, and/or tongue control present clinical challenges to the dentist in maintaining a dry field are good scenarios for considering using RMGI cement.\(^{27}\)

In a 2002, the authors of a study\(^{28}\) on surface pretreatments showed that pretreatment of the tooth surface with either polyacrylic acid or phosphoric acid resulted in an increase in bond strength to enamel compared to no pretreatment. Polymer tags in the enamel conditioned with either of these acids were revealed to exist that might involve a micromechanical bond.

There are times when a tooth is prepared for a casting that might include removing an existing restoration. Under this restoration, there may be some sclerotic dentin. It has been shown that RMGIs have a chemical bond to sclerotic dentin that is stronger than a bond that results from etching dentin and placing a dentin bonding agent.\(^{29}\) Ideally, when a preparation is made for a cast restoration, all the caries would be removed. There is, however, the possibility that some caries-affected dentin will remain. Operators should be aware that the bond strength of an RMGI to caries-affected dentin is higher than the bond strength of a GI to caries-affected dentin.\(^{30}\)

Mitchell\(^{31}\) writes that clinicians should be aware that metal posts cemented with an RMGI might be difficult or impossible to remove if access to the root canal system is subsequently required. He goes on to suggest that, when mechanical retention is compromised, an RMGI cement should be used.

Some clinicians may apply a cavity disinfectant to the completed preparation. A 2009 study\(^{32}\) showed that the application of 2% chlorhexidine gluconate did not interfere with the microtensile strength of GI materials to both sound and caries-affected dentin. Additionally, it has recently been reported that the application of glutaraldehyde-HEMA densensitizers to the preparation does not interfere with the use of a RMGI as the final cementing agent.\(^{9}\)

Being that both GI and RMGI products are water-based, clinicians should be aware of the expiration date of the product in use. Although the product may appear clinically usable after its expiration date, viscosity may be altered and strength reduced. It has been suggested that using a hermetically sealed container would maximize storage stability.\(^{33}\)

Previously, low film thickness was mentioned as a preferred characteristic of for an ideal cement. RMGIs are known for their low film thickness. The advantage this offers is that less material can be placed inside the casting, helping to eliminate the hydraulic issues associated with replacement of the prosthesis.\(^{27}\) Also, this would reduce the chance of the casting not being fully seated.

GIs and RMGIs are available in powder-liquid, paste-paste, and encapsulated formulas. The powder-liquid versions are usually less expensive. Clinicians will find that the paste-paste products will produce equal and consistent amounts of both components (based on the manufacturer’s research). These delivery systems also allow for easier cleanup as do the encapsulated products that have no need for hand mixing. Dentists who use a syringable delivery system that includes an automix tip will find that these are fast, easy to use, convenient, and reduce the amount of air

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**Figure 3.** Radiograph after post removal.

**Figure 4.** Cast post and core were easily seated (due to the low film thickness of just 10 µm) with the improved resin-modified glass ionomer cement (FujiCEM 2 [GC America]).
in the final mix compared to hand mixing.34

MINI CASE REPORT
The following is a clinical situation demonstrating the use of FujiCEM 2. An 82-year-old gentleman came to our office complaining that his crown kept coming out and that it had been temporarily fixed in the past. He explained that, originally, a fiber post was used and that this broke soon after it was placed. His medical history was insignificant.

A clinical exam and radiograph of tooth No. 8 revealed a cast post and core with a very short post (Figures 1 and 2). Additionally, it confirmed what the patient had described, that the temporary fix was with small pins. The gentleman was advised that a better long-term prognosis could be expected if the remaining fiber post was removed and a new cast post and core made, with a longer post that could be retrofit to the existing crown (as those margins were acceptable).

After the fiber post was removed by the local endodontist, the patient returned for completion of the restorative treatment (Figure 3). Using Duralay (Reliance Dental), the pattern for a post and core was made and sent to our dental laboratory team to be cast.

At the insertion visit, isolation was achieved using cotton rolls, and the cast post was cemented with FujiCEM 2 (Figure 4). Next, the patient's crown was cemented with FujiCEM 2 (Figure 5). Excess cement was removed after one minute, once the material reached a rubbery consistency.

DISCUSSION
GC FujiCEM has been available a number of years and has enjoyed much success. The improved version, FujiCEM 2 (demonstrated in this case example), is a recently introduced RMGI paste-paste cement (Figure 6).

FujiCEM 2 is a 2nd generation RMGI luting cement. It was chosen as the final cement for 5 important reasons:

1. As the gentleman wanted this to not “keep falling out,” the early high compressive and flexural strength of the product should accomplish his goal.

2. Being an RMGI, it chemically bonds to tooth to maintain a marginal seal, reducing microleakage and recurrent decay (fluoride release). This is important for all patients, and especially for this elderly retired gentlemen on a fixed income, as it would reduce the chance of needing a new crown due to recurrent decay.

3. Although the cast post is fitted to the prepared canal, a luting agent is required for retention and seal. The cement chosen for this case has a low film thickness of 10 µm that allowed the casting to be easily and properly seated.

4. The use of stronger cements helps to ensure the retention of indirect restorations. This 2nd generation RMGI has increased bond, flexural, and compressive strengths. A flexible long chain monomer gives the material its higher flexural strength, acting like a shock absorber and making it suitable for all high-strength all-ceramic restorations, in addition to metal-based ones. This (flex) characteristic better resists occlusal forces. The modified filler-surface treatment creates a strong bond between the glass particles and the resin, translating to a reduction in the chance for subsequent restoration dislodgement.
5. Although not a factor in this clinical case (nonvital tooth), when used with vital teeth, this and other RMGI cements pose little or no risk of postoperative sensitivity.

**IN SUMMARY**

We have many materials and products available to us. It is imperative that we stay abreast of this aspect of dentistry as newer and potentially more effective ones are developed and introduced into the market.

**REFERENCES**

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1. In a 2005 survey of dental schools in the US and Canada, it was concluded that there was no agreement among the schools as to which material was appropriate for any given clinical scenario.
   a. True       b. False

2. One article, published in 2013, states that the resin-modified glass ionomer cement (RMGI) is currently the least used cement.
   a. True       b. False

3. A 2004 survey indicated that more than half of all PFM crowns were cemented using a RMGI.
   a. True       b. False

4. A disadvantage of glass ionomers (GIs) is the inability of these materials to bond with the tooth.
   a. True       b. False

5. It has been shown that the fluoride release (GI cements) does inhibit secondary caries and that fluoride is toxic to those microorganisms associated with caries.
   a. True       b. False

6. The difference between GIs and RMGIs is that the RMGIs are additionally composed of water-soluble polymers or polymerizable resins.
   a. True       b. False

7. Operators should be aware that the bond strength of a RMGI to caries-affected dentin is higher than the bond strength of a GI to caries-affected dentin.
   a. True       b. False

8. RMGIs are known for their high film thickness.
   a. True       b. False

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ANSWER FORM: VOLUME 33 NO. 7 PAGE 130

Please check the correct box for each question below.

1.  ☐ a. True  ☐ b. False
2.  ☐ a. True  ☐ b. False
3.  ☐ a. True  ☐ b. False
4.  ☐ a. True  ☐ b. False
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