Bioactive materials support proactive dental care

By John C. Comisi, DDS, MAGD

Resin bonding of the human dentin has become a “standard” in the United States and Canada. There are more than 80 different bonding systems on the market today. We have seen events evolve through multiple generations in an attempt to “simplify” the bonding process. Yet, as these agents have simplified, many in our profession have seen many challenges arise.

A significant number of reports in the literature have been showing that the “immediate bonding: effectiveness of contemporary adhesives are quite favorable, regardless of the approach used [however] in the long term, the bonding effectiveness of some adhesives drops dramatically.” The hydrophilicity that both etch-and-rinse and self-etch bonding agents offer initially in the dentin-bonding process becomes a significant disadvantage in terms of long-term durability.

It is this hydrophilicity of simplified adhesive systems combined with other operator-induced challenges that contribute to these failures. Tay, Carvalho, Pashley, et al. have reported that these bonding agents do not coagulate the plasma proteins in the dentinal fluid enough to reduce this permeability. The fluid leaks contribute to the incompatibility of these simplified adhesives and dual-auto-cured composites in direct restorations and the use of resin cements for luting of indirect restorations. The term “water-tree” formation has been coined to describe this process, which originated from the tree-like deterioration patterns that were found within polyethylene in solution of underground electrical cables. It is now being applied to the water blisters formed by the transfer of dentinal fluid across the dentin-bonding interface. “These water blisters...act as stress raisers and form initial flaws that cause subsequent catastrophic failure along the adhesive/composite interfaces.”

The previously mentioned plasma proteins are released by the dentin when subjected to acids and cause hydrolytic and enzymatic breakdown of the dentin and resin bonding agent interface. These enzymes are called matrix metalloproteinases (MMPs). Currently, there are only three methods of reducing these MMPs: 1. percent chlorhexidine solutions that are used prior to application of bonding agents; etchants containing benxylumion chloride, otherwise known as RBC (e.g., Rivo’s Uni-either products); and polyvinylphosphonic acid-producing products (glass ionomer and resin-modified glass ionomers).

Due to the short efficacy of these chlorhexidine solutions being used before bonding, this methodology has come into question as of late. Etchants with RBC have been shown to be valuable in the reduction of MMPs and should be considered in all bonding procedures.2 However, the most intriguing methodology of reducing MMPs and remineralizing tooth structure is with the use of glass ionomer cements (GIC) and resin-modified glass ionomers (RMGIC).

Glass ionomers and resin-modified glass ionomers

Glass ionomer cements have long been used as a direct restorative material. Their early formulations made the material difficult to handle, and consequently, GICs are most often used in an undentified situation in dental restoration. However, these materials, although intended for temporary applications and pre-capsulated presentations, have many properties that make them ideal for the restorative process.

The work of companies such as SDI North America (Riva product line), GC America (Fugi product line) and VOCO have continued to make great strides in improving these products for easier and longer-lasting use of GIC and RMGIC products.

First, these materials are bioactive, and up until recently, they were the only materials with this property, that is they have the capacity to interact with living tissue or systems. Glass ionomers release and reabsorb ions from the oral cavity. This transfer of calcium phosphate, fluoride, strontium and other mineral into the tooth structure helps the dentition deal with the constant assault of the acids nature of day-to-day ingestion of food and beverages and encourages remineralization, and the incorporation of calcium phosphorous into the acid in today’s GICs create polyvinylphosphonic acid.

This property of GICs makes them a major agent in the reduction of MMP formation, and thereby minimizing if not eliminating the collagen break down commonly found in many resin-dentin bonding procedures. Second, they bond and ultimately form a union with the dentin by chemically fusing to the tooth. The combination of the polyacrylic acid and the calcium fluoroalumino silicate glass typically found in GICs react with the tooth surface, which releases calcium and phosphate ions that then combine into the surface layer of the GIC and forms an intermediate layer called “the interdiffusion zone.”

No resin bonding agents are required during this chemical fusing to the tooth structure. This ion release helps inhibit plaque formation and provides an acid buffering capability that helps to create a neutralization effect intrinsically. In addition, these GICs have very good marginal integrity with better cavity-sealing properties, have better internal polished resistance and microleakage over extended periods of time, have no free monomers, can be built filled and offer excellent biocompatibility.

Another important consideration is that GICs act as demineralizing materials, which makes them very sensitive for use in the intraradial cavity. The transfer of dentinal fluid from the tooth to the GIC essentially creates a “self-propagating microfractures of glass ionomer based materials.”

Serves to deflect or blunt any cracks that attempt to propagate through the matrix [and]...plays an adjuvant role by obliterating porosities which delay the growth of inherent cracks in the GIC under loading.4 The intermediate layer of the GIC provides flexibility during function and loading and acts as a stress absorber at the interface of the restoration and the tooth.

Resin-modified glass ionomers (RMGIC), which are a hybrid of traditional glass ionomer cements with a small addition of light-curing resin, exhibit properties intermediate of the two materials.4 This material has been shown to have properties similar to GIC, but with better esthetics and immediate light cure. RMGICs have been shown to undergo slight internal fracturing from polymerization shrinkage, yet have an inherent ability to remove broken bonds and reshape to enforce new forms.5 Application of RMGIC to all cut dentin is Class II composite restorations has been shown to “significantly reduce micro-leakage along (the) axial wall of the restoration,” and helps prevent bacterial invasion of the restored tooth. RMGIC biomaterials are multifunctional molecules that can adhere to both tooth structure and composite resin, thus providing an improved sealing ability by chemical or micromechanical adhesion to enamel, dentin, cementum and composite resin.

And like GICs, can be built filled to reduce the amount of composite necessary to restore the cavity preparation and act as dental substrates in the restoration.6 The use of GIC and RMGIC in the restoration of posterior Class V restorations and conservative Class I restorations provides a predictable seal.

They are easy to place and reasonably forgiving, even in a slightly moist environment. They hold well in a moist but not wet environment, so familiarity with technique is imperative as it is with all dental restorations.

I will often use Riva SC (SDI) or Fuji 9 GP Extra (GC America) in posterior placed radical approaches.7 Polishing and shaping of the materials must be done with water spray and fine cross line composites polishing burs and polishing so as not to destroy the surface of the material (Fig. 8).

The use of RMGIC products, such as Riva LC or Fuji II LC, is great in bicuspid and anterior Class V restorations, especially in high caries prone areas.8 Class II restorations, however, has always presented a challenge to the clinician. If the operator wanted to use GIC or RMGIC, there was no easy way to do this that appeared to provide satisfactory results. It is with this in mind that the “sandwich technique” was developed.

It was thought that using the properties of GIC to bond to the tooth and then applying resin-bonding agents and composite to the set GIC could help reduce sensitivity and bond failures typically seen in resin-bonded composite (RBC) techniques.

Typically, the GIC is placed in the preparation, allowed to set, cut back to ideal form and then bonded to the RBC as to not destroy the integrity of RICs to the set GIC often creates many failures. The materials by themselves are incompatible over the long term. The modified sandwich technique evolved as a means to overcome this problem. Placing RMGIC over set GIC and then applying resin-bonding agents to do so provided a better solution, but was laborious and time consuming to do, as is the sandwich technique.

The Co-Cure Technique

In 2006, an article was published9 that, in my opinion, has revolutionized the way I approach direct posterior restorations and direct restorations as a whole. The article presented a radical approach to direct posterior restorations, called the Co-Cure Technique. This technique is used to amalgamate the photopolymerization of two different light activated materials that involves the “sequential layering of GIC and RMGIC composite resin and RMGIC resin prior to placement.” The idea is to create a “hybrid layer” and before the initial set of the GIC [which] enables an efficient singe visit placement of a direct restoration.10

In the Co-Cure Technique, the composite restorations do not require a
having the patient bite or by the restoration material to create your away the excess GIC and composite in an unfilled resin material (i.e., Riva to slightly overfill the preparation. The restoration is evaluated for complete cure and then a layer of an un-filled resin is placed on the exposed GIC/RMGIC/composite complex and cured for an additional 40 se.

The matrix band is removed and the restoration is trimmed and polished as any typical RBC restora-

GIC/RMGIC/composite complex filled resin is placed on the exposed RMGIC is a resin-modified, light-cured bond-
ing agent because the bonding agent is essentially the RMGIC. The RMGIC acts as the interface between the GIC and the composite mate-

It is also envisioned that the incor-

poration and utilization of these na-

nopolymers in the form of nanorods, RBCs, RMCs, RMCS, RMGICs, and composites that contain pre-reacted glass silicate glass reacted with polyacrylic that just like a GIC, just before being incorporated into the composite. These giomers are resin-based com-

stitutes the use of 37 percent phos-
phoric acid to prepare the tooth for porations in the traditional sense, used in

It has also been shown that tradi-

cal, restorative dentistry.

Another recent interesting product release is from Bisco and is called TheraCalLC. This is a light cured com-

The restoration is cured for 30

minute once the matrix has been

The tooth is then dried but not des-

The matrix material is then

Hydrophobic Prophylactic Matrices placed next is hydrophilic.

After placement of an appropriate direct posterior restoration, the tooth is dried but not des-

I have found that an entire three-
surface posterior restoration can be accomplished in less than three minutes once the matrix has been placed. Typically, finishing the restora-
tion can also be done in less than three minutes. This makes the direct posterior preparation quite ef-

Physical properties by increasing the composite and shape, plus their bioac-

Giomers

Fig. 11

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Giomers are resin-based com-

The matrix material is then

Porcelain veneers are resin-based com-

resin and cure for 20 seconds.

Bond LC). This product is a specially

When I use this material in the Co-

Curing of new dentin.

Another recent interesting product release is from Bisco and is called TheraCalLC. This is a light cured composite material used to seal and protect the dentin-pulp complex. It is the first of a new class of internal pulpal protective materials known as resintempered calcium silicates (RMCSs). It acts as a pulp capping and liner material. Calcium hydroxide (CH) has been the ‘gold standard’ for many years. However, it has always had difficulties in lining a retainer under RBC adhesives. In fact, despite their frequent use, the success of CH-based therapies is only 30 to 90 percent.10

Resin-modified, light-cured bonding agents

Another advancement that I have been working with is a product that is a resintempered, light-cured bonding agent (STI, North America: Riva Bond LC). This product is a specially formulated liquid RMGIC that can be used to bond composite restora-

Conclusion

It is in my belief that using bioactive materials in the provision of care for my patients has contributed to the success of the case I have been providing in this way. I have pro-

References


2. C. M. Amaral, DDS, MS, PhD, A. K. Beden-Russo, DDS, MS, PhD, L. A. F. Pimenta, DDS, MS, PhD. M. S. Shinohara, DDS, M.S., M. G. Khadikar, DDS, MS, PhD. Effect of long-term water storage on etch-and-rinse and self-


The full list of references is available from the publisher.

Fig. 13 Fig. 14 Fig. 15

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