Bioactive materials support proactive dental care

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Resin bonding of the human denti-
tion has become a “standard” in the United States and Canada. There are more than 80 different bonding sys-
tems on the market today. We have seen evolu-
tion through multiple generations in an attempt to “simpl-
ify” 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 effec-
tiveness of contemporary adhesives is quite favorable, regardless of the approach used [however] in the long term, the bonding effective-
ness of some adhesives drops dra-
matically.”1 The hydrophillicity 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 hydrophillicity of simplified adhesive systems combined with other operator-induced challenges that contribute to these failures. Tony Carvalho, Paulley, et al. have reported repeatedly in the literature of this problem.2 They continue to report that these bonding agents do not coagulate the plasma proteins in the dentinal fluid enough to re-
duce this permeability. The fluid droplets contribute to the incompat-
ibility of these simplified adhesives and self-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-
sulation 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 blis-
ers” act as stress raisers and form initial flaws that cause subsequent catastrophic failure along the adhe-
sive-composite interface.3

The previously mentioned plasma proteins are released by the dentin when subjected to acids and cause hydrolytic and enzymatic break-
down of the dentin and resin bond-
ing agent interface.4 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 benzalkonium chloride, otherwise known as BAC (e.g., Rivo’s Uni-etch products); and polyvinylphospho-

2. 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.5 Etchants with BAC have been shown to be valuable in the reduction of MMPs and should be considered in all bonding pro-

3. 2 percent chlorhexidine solutions.6 Another important consideration is that GICs are moist-curing ma-
terials, which makes them very sen-
sitive for use in the intracoronal cavity. The transfer of dentinal fluid from the tooth to the GIC essentially cre-
as a “self-healing mechanism” of glass ionomer based materials.7 It serves to deflect or blunt any cracks that form and should be placed into the matrix and … plays an adjunc-
tive role by obliterating porosities which delay the growth of inherent cracks in the GIC under loading.8

The intermediate layer of the GIC provides flexibility during function-
al loading and acts as a stress absorb-
er at the interface of the restoration and the tooth.9

Resin-modified glass ionomers (RMGICs), which are a hybrid of tradi-
tional glass ionomer cement materials with a small addition of light-curing resin, exhibit properties intermediate of the two materials.5 This material has been shown to have properties simil-
lar to GIC, but with better esthetics and immediate light cure. RMGICs have been shown to undergo slight internal fracturing from polymeriza-
tion shrinkage, yet have an inherent ability to remove broken bonds and reshape to enforce new forms.10

Application of RMGIC to all cut den-
in Class II composite restorations has been shown to “significantly re-
duce micro leakage along the axial wall” of the restoration,11 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 adhes-
ion to dentin, cementum and composite resin.

They, like GICs, can be built filled to reduce the amount of composite necessary to restore the cavity prep-
erties, have better inherent stress absorb-
ance and resistance to microleakage over extended periods of time; have no

GP Extra (GIC America) in posterior pre-
pared to a radical approach to di-

Class II restorations, however, have 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 pro-
vide satisfactory results. It is with this in mind that the “sandwich tech-
nique” was developed.

It was thought that using the proper-
ses 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 many 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 restoration. The inability of RBCs to adhere to the set GIC often creates many failures. The materials by themselves are incor-
patible over the long-term. The modified sandwich technique evolved as a means to overcome this problem. Placing RMGIC over set GIC — and then applying RBC to the GIC — 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 published8 that, in my opinion, has revolu-
tionized the way I approach direct and posterior restorations. The article de-
ned as the simultaneous photo-

The use of GIC and RMGIC in the restoration of posterior Class V res-
torations and conservative Class 1 restorations provided polymerization of two different light activated materials that involves “the sequential layering of GIC, RMGIC and composite resin prior to placement of posterior Class V restorations provides an excellent substitute for the initial set of the GIC [which] enables an efficient single visits placement.”12

In the Co-Cure Technique, the com-
posture restoration does not require a
boding agent because the bonding agent is essentially the RMGC. The RMGC acts as the interface between the substrate material and the final restorative material. It combines the GIC, RMGC and composites in a way to form what can be best described as a “monolithic biomimetic restoration.”

This restoration is an “open sandwich” type of sandwich technique. That is, the GIC component is exposed on the gingival and the occlusal surfaces. The restoration is then cured for 30 to 40 seconds with an LED curing light that generates at least 1,500 mw/cm². Appropriate light output is critical for all direct cured restorations, and assurance that appropriate output is provided by the curing light is needed for complete cure of any direct restoration.

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 30 seconds. The matrix band is removed and the restoration is trimmed and polished. As any typical RBC restoration would be.

I have found that an entire three-surface posterior restoration can be accomplished in less than three minutes since the matrix has been placed. Typically, finishing the restoration can also be done in less than three minutes. This makes the direct posterior restoration quite efficient and beneficial to the clinician and the patient because it provides a restoration that will help enhance the healing of the dentin and reduce recurrent decay and restorative failure.

Technique procedure (Fig. 14)

After placement of an appropriate dental matrix, the technician incorporates the use of 37% phosphoric acid to prepare the tooth for the restoration. The acid is essentially “flooded” into the preparation in a similar manner to doing a “total etch” on tooth structure. The tooth is then dried but not desiccated. The restoration area is then prepared with an etchant and air rinsed. Fill the preparation with the triturated GIC mate material up to the level of the restoration. The restoration is placed and light cured (RMGC in a very thin layer to cover the GIC and walls of the preparation). Fill the preparation with self-polymerizing Tricure over the previous materials to slightly overfill the preparation. With a large round burshiner dipped in an unfilled resin material (i.e., Riva Co-Cure, Shofu Dental, Japan) wipe away the excess GIC and composite restoration material to create your margins and prevent ditching and white lines.

The occlusal table of the restoration can then be compressed gently with a plastic occlusal matrix by either having the patient gently rest on the operator pressing gently with his thumb or forefinger to improve the contact of the occlusion.

This will help reduce the time it took to volved in creating the final occlusion of the restoration by creating a functional occlusal scheme. The restoration is then cured for 30 to 40 seconds with an LED curing light that generates at least 1,500 mw/cm². Appropriate light output is critical for all direct cured restorations, and assurance that appropriate output is provided by the curing light is needed for complete cure of any direct restoration.

It is also envisioned that the incor- poration and utilization of these na- noparticles in the form of nanorods, nanowires, nano-composites, micro- orormers (organically modified ceramics) into dental restorative and biomimetic materials could provide bimo- metic (life-like) restorations. This will not only enable these materials to mimic the structure and aesthetics of the tooth structure, but will also be able to facilitate the remineralization of that structure.

As Saunders states in his conclusion, “such nanomorphological biomaterials could very credibly be the next trans- formative clinical leap” in restorative dentistry.

Conclusion

It is my belief that using bioactive materials in the provision of care for my patients has had a tremendous impact on the success of the care I have given in this way. I have provided ways to help the dentin to remineralize, to reduce the inflammatory response and improve the health of my patients.

I believe we are on the threshold of further bioactive material advance- ments and that learning and incor- porating these restorative advances into the day-to-day provision of care will continue to help our patients, our practices and our profession.

References


The full list of references is available from the publisher.