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 them evolve 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 longterm durability.2 It is this hydrophillicity of simplified adhesive systems combined with other operator-induced challenges that contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to contribute to these failures.3,4 They continue to...
bonding agent because the bonding agent is essentially the RMGIC. The RMGIC acts as the interface between the resin composite material and the tooth substrate. It combines the GIC and RMGIC complex in a way to form what can best be described as a "monolithic biomimetic restoration." This restoration is an "open sandwich" type of sandwich technique. That is, the GIC component is exposed anteriorly in Fig. 15 at the gingival portion of the restoration. It is quickly and efficiently accomplished after the removal of the reduced postoperative sensitiv- ity phase and with typical direct RBC techniques. I have been placing these types of direct postoperative restorations since 2008. They have become the cornerstone of my practice.

Technique procedure (Fig. 14)

After placement of an appropriate dentin matrix, the technician incor- porates the use of 37 percent phosphoric acid to prepare the tooth for restoration. The acid is essentially "flooded" into the preparation in a similar manner to doing a "total-etch." It is then rinsed off after five seconds of placement. The tooth is then dried but not des-iccated. The restoration is placed in Riva Composite II (GC) and the light-polymerized RMGIC in a very thin layer to cover the GIC and walls of the preparation. The RMGIC is then overlaid over the previous materials to slightly overfill the preparation. With a large round burr, the RMGIC is lightly sanded in an unfilled resin matrix (i.e., Riva Composite II, GC). The light-polymerizing agent (SDI, North America: Riva Composite II, GC) wipe away the excess GIC and composite restoration material to create your matrix and prevent chipping and white lines. The occlusal surface of the restoration can then be conditioned gently with a plastic occlusal matrix by either having the patient hold the material or the operator pressing gently with his thumb or forefinger to improve the condensation. This can help reduce the time in- volved in creating the final occlusion of the restoration by creating a func- tional occlusal plane. The restorations is then cured for 30 to 40 seconds with an LED curing light that generates at least 1,800 mw/cm². Appropriate light output is critical for all direct cured restora- tions, and assurance that appropri- ate output is provided by the curing light is needed for complete cure of any direct restoration.

The restoration is evaluated for com- plete cure and then a layer of an un- filled resin in the form of an exposed GIC/RMGIC complex composite is placed for an additional 30 sec- onds. 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 once the matrix has been placed. Typically, finishing the res- toration 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 the technique will help in reducing the healing of the dentin and reducing the recurrent decay and restorative fail- ure.

Nonotechnology in dental materials

This article involves the pro- duction of functional materials and structures in the range of 0.1 to 100 nanometers by various physical or chemical methods. Today, the de-velopment of nanotechnology has become one of the most highly ener- gized disciplines in science and tech- nology because it can stimulate the creation of a new class of products that have previously unimagined applications and functions. Several studies24 have shown that the inclusion of these types of nano- fillers or nanofibers into the dental materials (dental composites and bonding agents) can improve the physical properties by increasing the strength, polishability, wear resist- ance, aesthetics and bond strength in many dental applications.

It is also envisioned that the incor- poration and utilization of these na- noparticles in the form of nanorods, quantum dots, quantum spheres, and ormerons (organically modified ceramics) into dental restorative and bonding materials will enhance their bio- mimetic life-like restorations. This will not only enable these materials to mimic the natural and esthetic properties of the tooth structure, but will also be able to fine-tune the remineralization of that structure. As Saunders states in his conclusion, "Such nanobioceramic biomaterials could very credibly be the next trans- formative clinical leap" in restorative dentistry.

Glimmer

In 2005, an exciting advance- ment in bioactive materials is the development of glimmer products (Shofu Dental, Beautifil II, and Beau- tifill Flow Plus) that are resin-based com- posites that contain pre-reacted glass ionomer particles (8-PiG).

These particles are made of fluoro- silicate glass reacted with polyacrylic acid (just like a GIC), just before being incorporated into the resin. This cre- ates a new type of bioactive material. These glass ionomer products have properties in a manner similar to the RMGIC. They release ions and recharge with ions from the oral cavity, inhibit plaque formation and neutralize and buffer the acids of the mouth. Newer composite materials that have this property to date. I use these gimmers instead of traditional nano-hybrid composites in my restorations because of these properties. They complete the entire biomimetic and bioactive nature of all the co-cure procedures that I create. The Beautifill Flow Plus product line has also expanded the way that I cre- ate restorations due to their unique viscosities. These materials can be scratched (Fig. 15) and used in a restora- tive process I call the "modified resin cone technique" (Fig. 16). They can also be applied to create direct composite veneers that can be easily placed, sculpted and highly polished (Fig. 17). Easy placement, the ability to maintain position and shape, plus their bioac- tive nature, make these materials a "game changer."

Resin-modified, light-cured bonding agents

Another advancement that I have been working with is a product that is a resin-modified, light cured bonding agent (SDF, North America: Riva Bond LC). This product is a specially formulated liquid RMGIC that can be used to bond composite restora- tions in the traditional sense; used in traditional sandwich and modified sandwich techniques and, of course, used in the Co-Cure Technique. This concept is especially appealing in light of the research that indicates that RMGICs provide a "good margin" with standard glass margin- al seal when used as a bonding agent on cut dentin surfaces.21 I also believe slightly smaller light-cure tech- niques and when doing anterior res- torations. Using this technique I am able to get a completely biomimetic, bioactive restoration in both situa- tions because of the bioactive nature of the materials used. The technique for use of this RMGIC bonding agent with composite is as follows:

1. Etch with 37 percent phosphoric acid for 20 seconds.
2. Wash and dry but do not desiccate.
3. Triturate and apply the RMGIC by building with a micro-brush and cure for 20 seconds.
4. Place composite to fill the prepara- tion and cure as appropriate.

When I use this material in my Co-Cure Technique I just substitute it for the traditional RMGIC material that I would have used otherwise.

Resin-modified calcium sili- cates

Another recent interesting product release is from Bisco and is called TheraCal™ LC. This light cured bio- active material is used to seal and protect the dentin-pulp complex. It is the first of a new class of internal pulp protective materials known as resin-modified calcium silicates (RMCS). It acts as a pulp capping and liner material. Calcium hydroxide (CH) has always been the 'gold standard' in pulp capping for many years. However, it has always had difficulties in use as a liner under RBC adhesives. In fact, despite their frequent use, the success of CH based therapies is only 30 to 50 percent.21 It has also been shown that tradi- tional resin-based light-cured liners have been cytotoxic to cultured od-onto-larva-like cells, while light cured resin-modified MTA cemented provides the least cytotoxic effects.22 Based on this, the creation of this light-cured RMCS is a logical step in developing a solution for direct pulp protection. Calcium has been shown to be cru- cial to the formation of apatite, den- tin bridge formation and re-aparite potential of affected dentin. Addi- tionally, alkalinity also seems to be contributory towards this goal. This combination in the RMCS material appears to form good, hard and thick dentin bridges and stimulates den- tin pulp cells to turn into odonto-las- tinc dentin cells.23

This type of material represents a promising new direction in direct pulp-capping clinical procedures, with its ability to form apatite and further contribute to the formation of new dentin.

Conclusion

It is my belief that using bioactive materials in the provision of care for my patients has been one of the most success of the care I have provided in this way. I have pro- vided ways to heal the dentin, enhance the restoration 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 techniques into the daily to-day provision of care will continue to help our patients in our practices and our patients' practices and our patients' practices.

References


The full list of references is available from the publisher.