Tissue-Specific, Biomimetic, Direct-Application Tooth Repair

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A common topic for clinical technique articles seen in today's scientific journals and commercial dentistry publications is Class I or Class II repair of posterior teeth using various brands and formulations of bonded resin-based composite (RBC). Most of these articles demonstrate direct bonding of the filled resin to dentin, often with a first layer of diluted (high resin/low filler content or "flowable") RBC, followed by incremental build-up to full original contour of the tooth with an RBC of higher filler content. Few demonstrate or recommend use of a resin-modified glass ionomer (RMGI) liner or base for dentin replacement as an intrinsic step in the procedure. One such recent publication[1] claimed that "In the past, dentists used resin-based glass ionomer products to thinly line the base of preparations before placing bonding agents to prevent leakage and sensitivity. A flowable resin was then placed over the bonding agent to further reduce shrinkage effects. However, recent studies have found that this type of preventive technique is mostly ineffective." On the contrary, other clinicians consider dentin replacement with certain of the glass-ionomer systems an intrinsic part of the restorative procedure, not a passé, ineffective method.[2–5]

Pashley and colleagues[6] succinctly discussed resin/dentin bond degradation "due to the presence of activated endogenous matrix metalloproteinases (MMPs) that are neutral hydrolases. That is, the enzymes add water across specific peptide bonds to cleave them at neutral pH. The loss of collagen fibrils within the hybrid layer causes a loss of continuity with underlying dentin and a weakening of the coupling of resin composites to dentin." In the same publication, Pashley and colleagues reviewed current strategies in dentin bonding agent formulations to inhibit the action of MMPs so as to combat hydrolytic bond degradation and "increase the durability of resin-dentin bonds." This work gives hope that dental scientists and manufacturers can eventually solve the inherent problems that exist with long-term stability and effectiveness of resin/dentin bonding.

Practicing the concept of "tissue-specific tooth repair" obviates all concerns with the quality or longevity of resin/dentin bonding. When one considers that certain glass-polyalkenoate (glass ionomer) cement systems are ideal biomimetic dentin replacement materials and that they are able to bond chemically to RBC and tooth structure, concerns about resin/dentin bonding are moot.

Ruiz and Mitra reviewed the advantages of tooth restoration using an RMGI for dentin replacement.[7] They noted the following advantages to that approach:

- RMGI liners bond chemically to dentin and do not hydrolyze over time.
- Contraction stresses of polymerizing RBC are counteracted by presence of an RMGI liner.
- Cusp deformation associated with RBC polymerization shrinkage is decreased by the presence of an RMGI liner.

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- Postoperative tooth sensitivity is greatly decreased with an RMGI liner or base in place. (Some dentists, including this writer, report that such sensitivity is completely eliminated).
- Temperature changes occurring in the mouth affect tooth structure and RMGI similarly. That is, the respective coefficients of thermal expansion of tooth structure and glass ionomers are similar. This property, combined with chemical bonding, makes for less marginal leakage and marginal opening in response to intraoral thermal changes.
- Inclusion of fluoride ions in the calcium-aluminum fluorosilicate glass filler of glass ionomer cements has been shown not only to decrease solubility of adjacent tooth structure when challenged by acid but also provides an antimicrobial effect because of the presence of fluoride.

Another consideration is that when a defective margin develops recurrent caries years after original tooth repair, it is logical to believe that spread of the caries would be more self-limiting with a fluoride-containing bonded dentin replacement "under-filling." Simple repair of the defect could be achieved rather than more extensive material removal and re-restoration.[8] The idea that a bonded glass ionomer liner/base could self-contain new caries infection would make for an important and revealing in vitro experiment.

When all the above is considered, it is easy to see that the only disadvantage to use of an RMGI liner/base as a dentin replacement beneath an RBC enamel replacement is that treatment takes a bit longer for placement of the RMGI material. The photo-curing property of RMGI liners/bases renders the extra time minimal, and the long-term advantages are remarkable when compared with the alternative.

The photographs shown here detail "tissue-specific" Class I repair of a permanent molar that has an occlusal caries lesion and disto-occlusal Class II repair of a premolar (Figures 1 and 2). Note how modified traditional mechanical undercutting retention form works in harmony with the bonding mechanisms of the RMGI dentin replacement and the RBC enamel replacement material to stabilize and secure the two repair materials.

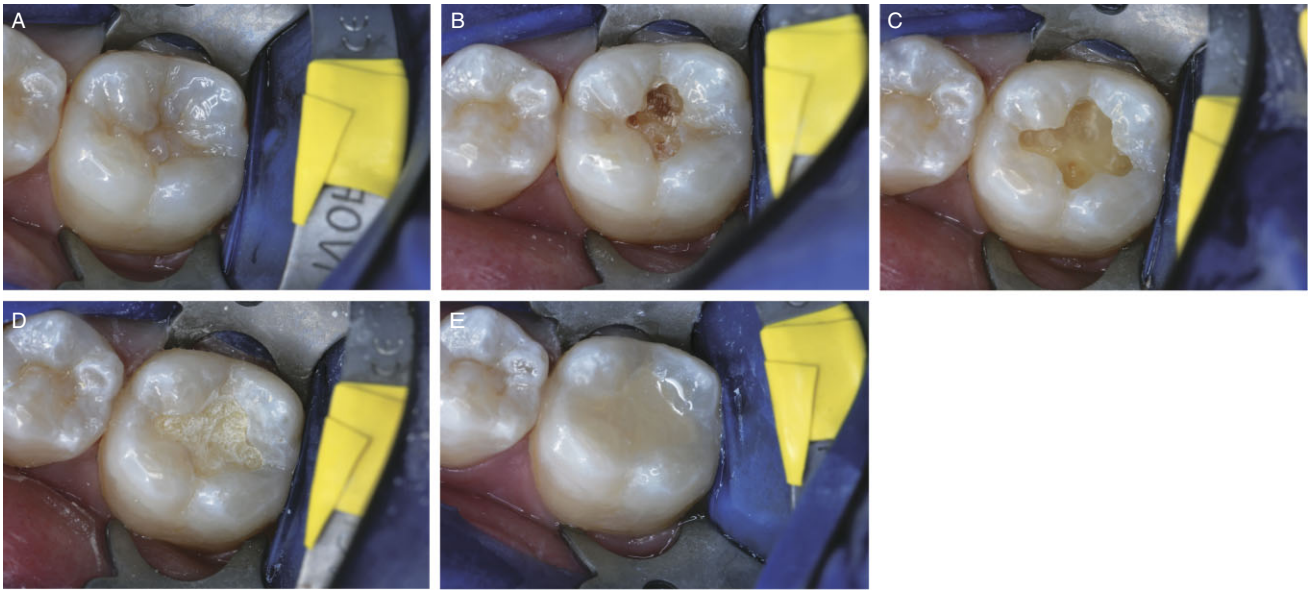

FIGURE 1. A, Typical Class I tissue-specific tooth restoration—hidden occlusal caries detected. B, Caries lesion exposed. C, Carious substance debrided. D, Resin-modified glass ionomer liner/base placed. E, Enamel replaced using bonded resin-based composite. Note peripheral excess resin-based composite serves as marginal sealant.

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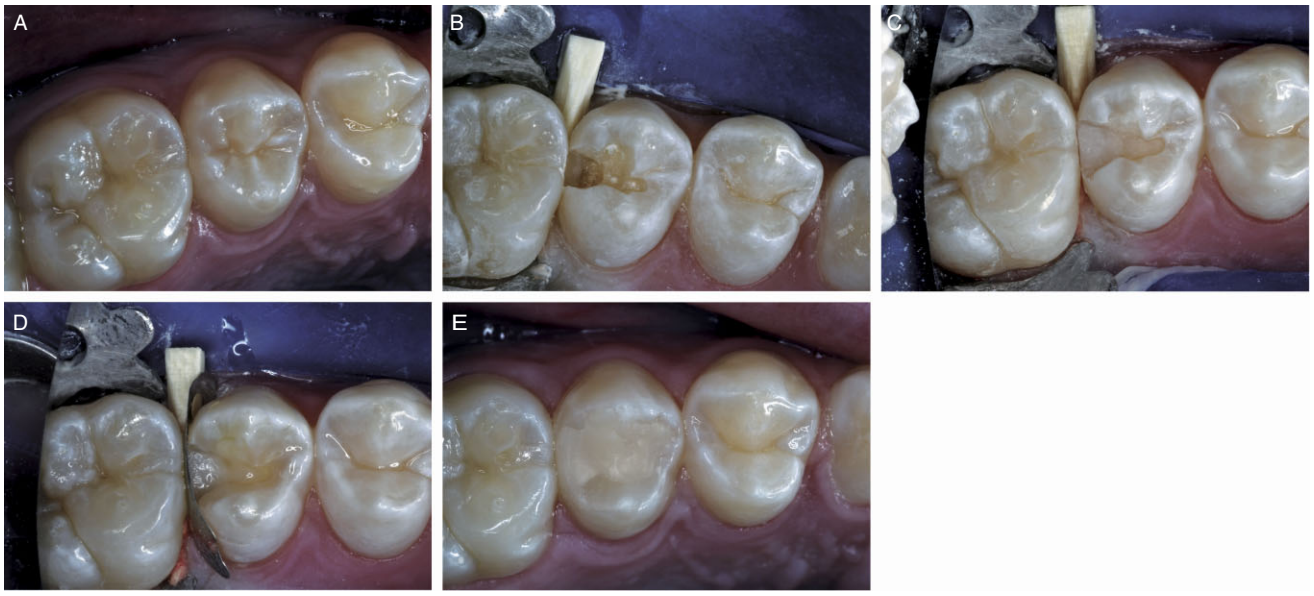

FIGURE 2. A, Maxillary premolar with proximal caries lesion detected on radiograph. B, Disto-occlusal (DO) caries lesion exposed/carious substance debrided/preparation completed. C, Dentin replacement resin-modified glass ionomer base placed. D, Contoured matrix strip secured in place and self-etching adhesive applied and light-cured. E, DO restoration 2 years postoperatively. Overlapping resin-based composite "flash" serves as bonded marginal sealant.

In summary, when one considers the physical properties, proven history, and handling characteristics of the respective tooth-colored tooth repair systems, an inescapable conclusion is that RMGIs are the best direct application dentin replacement materials available. Furthermore, the best RBCs are the most ideal direct application enamel replacements. When used in combination, these dental restorative systems give dentists the means to serve patients as well as can be with a tissue-specific, biomimetic approach to tooth repair. Until dental materials scientists produce a material that encompasses the form, function, and physical properties of both dentin and enamel, the use of RMGIs in combination with RBCs could perhaps be deemed the standard of care.

REFERENCES

1. Nash RW. Placing predictable posterior restorations. Inside Dent 2012;8:60–2.
2. Ferrari M. Use of glass-ionomers as bondings, linings, or bases. In: Davidson CL, Mjör IA, editors. Advances in glass-ionomer cements. Berlin, Chicago (IL): Quintessence; 1999, pp. 137–48.
3. Aboush YEY, Torabzadeh H. Clinical performance of Class II restorations in which resin composite is laminated over resin-modified glass-ionomer. Oper Dent 2000;25:367–73.
4. Croll TP, Cavanaugh RR. Posterior resin-based composite restorations: a second opinion. J Esthet Restor Dent 2002;14:303–12.
5. Croll TP, Cavanaugh RR. Tissue-specific, direct application Class II tooth repair: a case report. Compend Contin Educ Dent 2009;30:608–14.
6. Pashley DH, Tay FR, Imazato S. How to increase the durability of resin-dentin bonds. Compend Contin Educ Dent 2011;32:60–4.
7. Ruiz JL, Mitra S. Using cavity liners with direct posterior composite restorations. Compend Contin Educ Dent 2006;27:347–51.
8. Croll TP, Donly KJ. Resin-based composite margin repair. Inside Dent 2008;4:92–3.

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