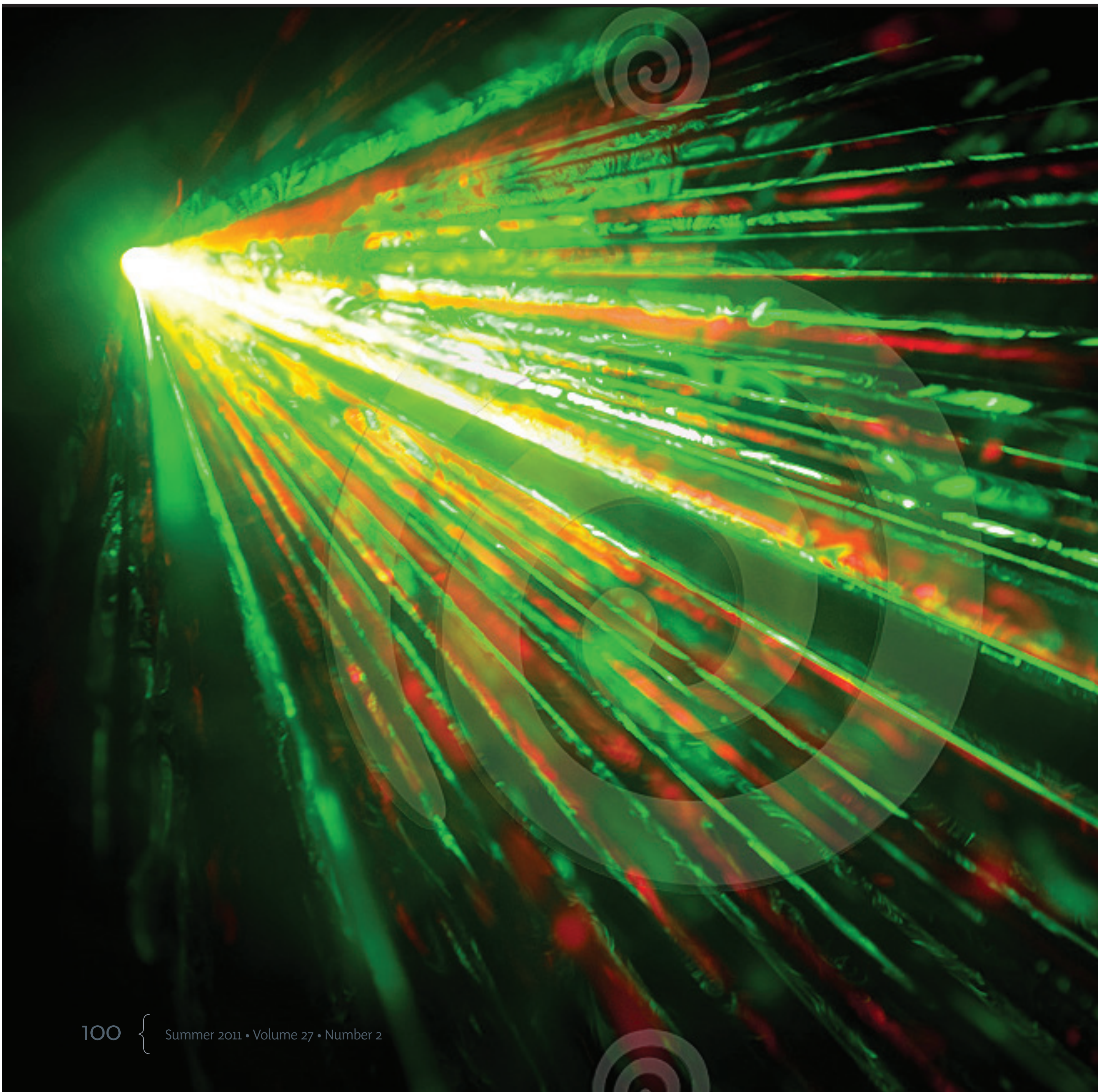
CREATING OPTIMUM Composite Restorations



Combining Glass Ionomer and Laser Technology

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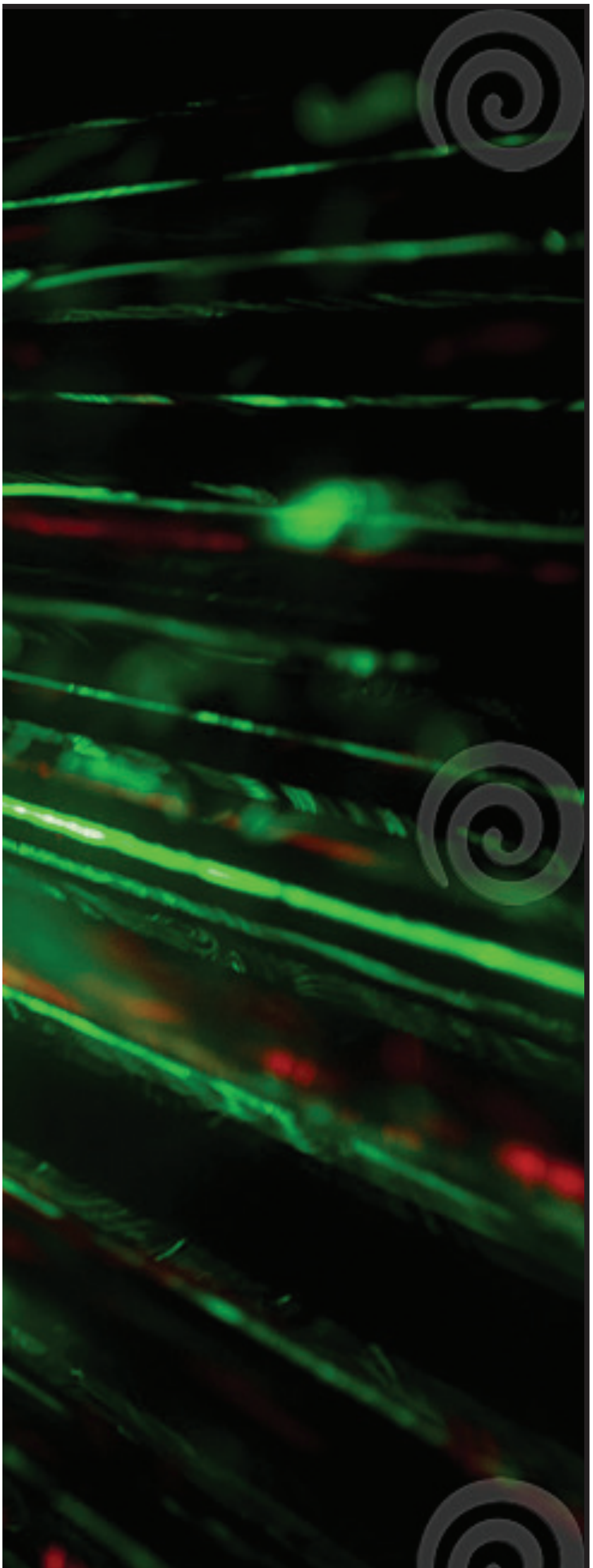

Introduction

Literature Review

The evolution of high-quality direct resin restorations has spanned almost five decades. Innovations in filling materials have led to stronger, more esthetic, and wear-resistant restorations. Several generations of bonding agents include: filled systems, release of fluoride and other agents, unit dose, self-cured catalyst, option of etching with either phosphoric acid or self-etching primer, and pH indicators. Studies have shown that a number of factors that can affect the bond strength to human dentin include substrate (superficial dentin, deep dentin, permanent versus primary teeth, artificial carious dentin), phosphoric acid versus acidic primers, preparation by air abrasion and laser, moisture, contaminants, desensitizing agents, astringents, and self-cured restorative materials. Results show that bond strengths can be reduced by more than 50% when bonding conditions are not ideal.[1]

Editor's Note: As a part of the AACD's sister relationship with the Japan Academy of Esthetic Dentistry (JAED), this article has been translated into Japanese and published in JAED's journal.

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Glass ionomer chemistry and modalities have been tremendous assets in allowing dentistry to make tooth structure more resistant to bacteria and decalcification processes. Composite restorations have become more predictable because of this. Beginning with the research efforts of Wilson and McLean in the 1970s and 1980s, [2-4] clinicians such as Mount5 reported that long-term decreases in microleakage could be achieved by taking advantage of the chemical adhesion between glass ionomer cement and dentin, as well as the mechanical union between composite resin and glass ionomer cement. This led to the development of the so-called "sandwich technique," in which glass ionomer cement is used as a lining under composite resin restorations particularly where the cavo-surface margin is in dentin.[5] Peutzfeldt and Asmussen, as well as Knight, found that an additional advantage was that glass-ionomer cement lining reduced wall-to-wall contraction and intercuspal stress would lead to decreased postoperative sensitivity to chewing.[6,7] Suzuki and Jordan introduced this to America in 1990 and reconfirmed that the marriage of these two dissimilar materials was synergistic and extremely beneficial to teeth.8 Davidson and Abdalla's research noted that the lack of glass ionomer lining under resin dentin bonding system/resin composite restorations resulted in a significant deterioration of marginal integrity under occlusal loading.[9] Manufacturers' changes in viscosity and strength have improved handling and durability over the years. Modifying glass ionomers with resins (glass ionomer composites [GICs]) has proven to be a great adjunct to the "sandwich technique."10 This is especially noteworthy in separate studies by Ngo and colleagues, and Knight and colleagues, who demonstrated with electron probe microanalysis (EPMA) and scanning electron microscopy (SEM), that both fluoride and strontium ions had penetrated deep into underlying hypocalcified dentin consistent with a remineralization process of the hydroxyapatite crystals.[11,12]

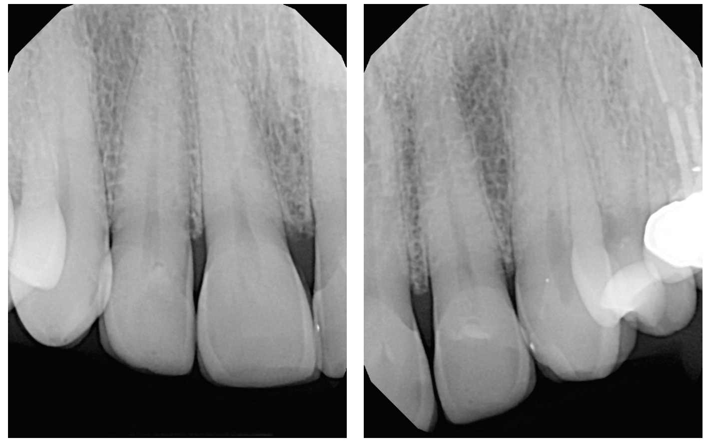
The introduction of lasers to restorative dentistry in the last 10 to 15 years has been a result of advances in the strength of erbium wavelengths and better delivery systems that are compact, efficient, minimally invasive, and user/patient friendly. Research on laser irradiation of enamel has demonstrated structural changes that resulted in a decrease in acid dissolution of the enamel. Dentin irradiation produced changes in surface morphology that improved bonding of restorative resins.[13] Moldes and colleagues have demonstrated lower microleakage scores with composite bonding on teeth prepared by erbium laser compared to conventional drills.[14] However, many studies have found more optimal bond strengths with added acid etching of 20 to 40 seconds with 37% phosphoric acid.[15,16]

The cause and prevention of dental caries also must be considered. Per Hurlbutt, Novy, and Young:[17] "Science suggests it is pH, rather than sugar, which is the selective factor for cariogenic plaque biofilms. Low salivary pH promotes the growth of aciduric bacteria, which then allows the acidogenic bacteria to proliferate creating an inhospitable environment for the protective oral bacteria. This allows for a shift in the environmental balance to favor cariogenic bacteria, which further lowers the salivary pH and the cycle continues. Simple chemistry dictates at what pH enamel and cementum/dentin will demineralize. By controlling pH it is possible to alter the plaque biofilm, remineralize existing lesions, and perhaps prevent the disease altogether." This is critical in managing risk of current and future dental caries. Therefore, having a management system that follows the caries management by risk assessment (CAMBRA) guidelines is essential clinically and medico-legally.[18]

With the confluence of these technologies, very predictable and efficient modalities can be used to serve patients. The following case reports demonstrate caries management and modern implementation of the sandwich technique.

Case Presentation #1

A 52-year-old male patient, who had always feared dentists, presented for a continuing care visit that was two years overdue. His dental history involved numerous restorations including fillings, veneers, and crowns. Following updated medical history and radiographs **(Figs 1a & 1b)**, an initial caries assessment was done using a Cari-Screen test (Oral Biotech; Albany, NY), which uses adenosine triphosphate (ATP) bioluminescence to identify oral-bacterial load and has been proven to correlate with patients' risk for decay.[19] A swab sample of the plaque from the patient's teeth, combined with special bioluminescence reagents within the swab, creates a reaction that is then measured with the meter. The Cari-Screen gives a score between 0 and 9,999. A score under 1,500 is considered relatively healthy, while a result above that shows considerable risk for decay. This patient scored 2,590 **(Fig 2)**; indicating the need for more proactive modalities, including the use decalcification processes.



Figures 1a & 1b: Pretreatment radiograph provides only a small measure of the decalcification of the teeth.

Figure 2: Cari-Screen results provide numerical measurements helpful in identifying risk.

of Cari-Free rinses to lower the pH, alter the biofilm, and remineralize any low-risk lesions.

All unrestored existing enamel pits and fissures **(Fig 3)** were evaluated with laser fluorescence using the DIAGNOdent Classic system (Kavo Dental; Charlotte, NC) **(Fig 4)**. With a diagnostic threshold of 20-25, teeth #7 and #10 scored 64 and 55 respectively. Given the high caries risk, restorative measures were indicated. The conservative nature and pain control of the laser allowed for an ideal minimally invasive treatment to serve this patient's clinical and emotional needs.

After managing the patient's expectations for care (i.e., discussing the laser experience), lip retraction was applied to improve isolation in a comfortable manner. A 90-second "laser analgesia" application was performed with a laser tip (usually a 600 µm glass quartz tip) defocused from and perpendicular to the enamel surface at a height of 10 mm, with a setting at 4.5 Watts, 60% water, and 30% air. When the analgesia cycle was completed, the laser tip was brought within .5 to 1.0 mm of the enamel and pointed at a perpendicular angle to the lingual pit, which works well on smooth surface lesions. Carefully dissecting and ablating the decalcified and carious areas along the grooves and trying to preserve tooth structure, the enamel was cleansed at this setting, while the less mineralized, carious dentin was ablated at 3.5 Watts, 60% water, and 30% air. Since the laser tip is only end-cutting, any small areas undermining enamel can be removed with spoons or a sharp slow-speed round bur, that patient tends not to object to **(Fig 5)**. Any white "cratering" caused on the cavo-surface or esthetic areas were smoothed with a medium diamond to avoid any shine-through in the future bonding.

The laser tooth treatment was followed by a chlorhexidine scrub with Consepsis (Ultradent; South Jordan, UT). Fuji Lining LC (GC America; Alsip, IL), a flowable glass ionomer composite, was placed and cured **(Fig 6)**. A layered etching of the enamel and liner was performed with 37% phosphoric acid at 15- and 5-second intervals respectively **(Fig 7)**. The preparation was rinsed thoroughly and excess moisture removed, but the tooth was not dried. After resin bonding of the enamel, G-Aenial Universal Flo composite (GC America) was placed in the prepared area because of its high strength, higher wear resistance, and high gloss retention **(Fig 8)**. It was cured using the Radii Plus (SDI Dental; Bayswater, Australia) LED light for 20 seconds. Final polishing was minimal after the occlusion was checked **(Figs 9 & 10)**.

Figure 3: Preoperative intraoral conditions show the decay in the lateral incisor pits.

Figure 4: DIAGNOdent readings provide more helpful information than using just an explorer in determining the degree of decalcification beneath the enamel.

Figure 5: Using an ErCr:YSGG laser to remove decay and condition the dentin.

Figure 6: Laser preparation of teeth is often done without anesthesia.

Figure 7: Fuji Liner LC glass ionomer can be precisely applied in tight preparations.

Figure 8: Total etch technique conditions enamel and dentin.

Figure 9: Flowable composite seals the glass ionomer to complete the sandwich.

Figure 10: Immediate post-treatment photograph demonstrates healthier-looking teeth that reflect the benefits of combining the technologies employed.

Case Presentation #2

This 37-year-old male patient had not been to a dentist in six years. After full records (digital radiographs, photographs, and models) and a complete examination, he was diagnosed with early periodontitis and occlusal trauma. Various carious lesions also were detected on the DIAGNOdent **(Fig 11)**. Fortunately, his Cari-Screen results indicated he was at low risk in terms of salivary pH and biofilm.

Following conservative periodontal care and occlusal therapy with a Kois deprogrammer (Panadent; Colton, CA) and equilibration, the decayed areas were treated in a minimally invasive manner with no anesthesia. After isolation with a rubber dam, laser therapy of the lesions was performed as aforementioned **(Fig 12)**. Preparation preserved proximal enamel and was about 1 mm into dentin **(Fig 13)**.

When the decay was removed, the tooth was restored using a "closed sandwich technique"—with the glass ionomer composite sealing/replacing the dentin and protected from oral fluids by composite that acts as an "enamel replacement" **(Fig 14)**. Composite materials are chosen based on the remaining tooth structure available, particularly in the critical biomechanical areas of the peripheral rim of enamel and triangular ridges.[20] Following a Consepsis rinse, a layered etching of the enamel and liner was performed with 37% phosphoric acid at 15- and 5-second intervals respectively **(Fig 15)**. The preparation was rinsed thoroughly and excess moisture removed, but the tooth was not dried.

A capsule of a thick GIC (Fuji IX) was activated and triturated for placement into the deeper parts of the preparation **(Fig 16)**. This layer was further adapted with a Microbrush (Grafton, WI) painted with G-Bond (GC America) which also primed the self-curing GIC and the enamel substrate. The resin was left undisturbed for 10 seconds and air-thinned under suction. To seal the "sandwich," a flowable composite (G-Aenial) was precisely placed on top of the GIC while contacting the enamel walls and then cured for 10 seconds **(Fig 17)**.

The evidence-based findings of the past, in addition to current advances in know-how and materials, have built a brighter future for our profession.

Figure 11: Preoperative image of demineralized teeth.

Figure 12: Laser and bonding treatment are best done with isolation for better control of the oral environment.

Figure 13: Maintenance of the peripheral rim of enamel is more easily done with laser care.

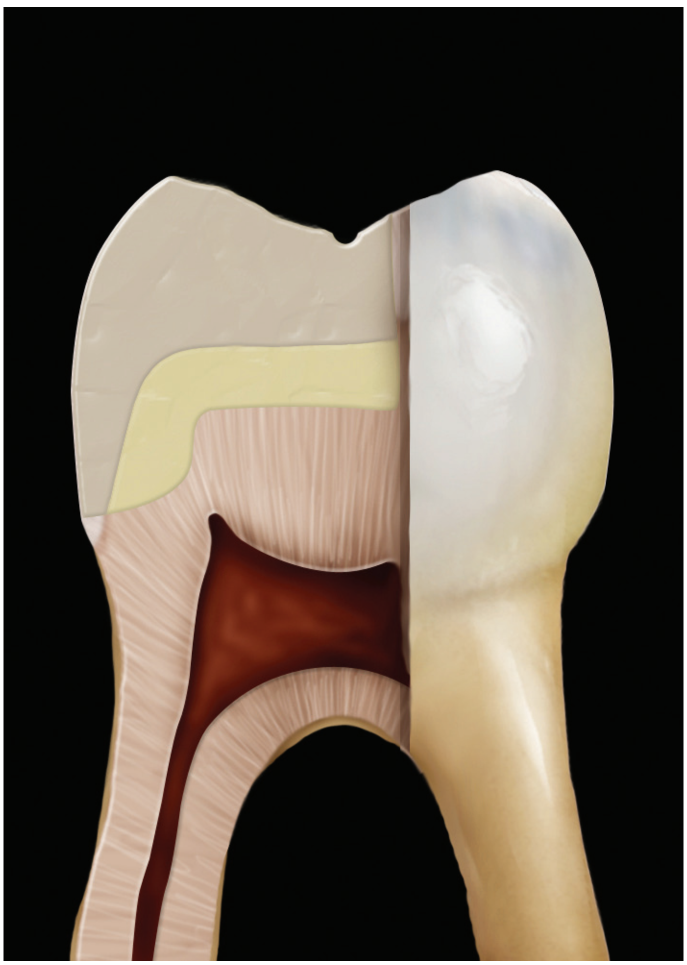


Figure 14: Layered diagram of the closed sandwich restoration (Printed with permission from GC America.)

As an enamel replacement, a compule of Kalore (GC America) was carefully layered over the flowable and adapted to the enamel walls using "gold" instruments (Cosmedent; Chicago, IL) that were helpful in burnishing the restorative materials to the cavo-surface margins **(Fig 18)**. After curing multi-directionally for 20 seconds, gross finishing and occlusal adjustments were done with a 12-bladed OS carbide bur (Brasseler USA; Savannah GA) **(Fig 19)**. This was made easier with a patient who was more aware of their occlusion with no anesthesia and a predictable closing pattern.

Final polishing was performed with GC Pre-Shine and GC Dia-Shine points and GC Dia Polisher paste using a light buffing pressure with a Robinson bristle brush. A natural-looking result that preserved the structural integrity and esthetics of the tooth was achieved **(Fig 20)**.

Conclusion

The synergistic combination of updated technologies by means of lasers, glass ionomers, and composites has allowed for new standards to be achieved in restoring posterior teeth. In addition, improved criteria for prevention and risk assessment have created even more minimally invasive methods of preserving natural enamel and creating an anti-aging theme in contemporary dental care.

Greater levels of strength and marginal seal, remineralization of remaining tooth structure, and color mimicking are creating better biomimetic results that allow patients to receive greater value for their commitment to improved health. Furthermore, dental professionals have a better opportunity to achieve more predictable posterior composites with fewer postoperative complications and greater peace of mind. The evidence-based findings of the past, in addition to current advances in know-how and materials, have built a brighter future for our profession.

Figure 15: Total etch takes advantage of the microanatomy of enamel and dentin.

Figure 16: Fuji IX is an excellent dentinal replacement.

Figure 17: G-Aenial Flow has a very precise delivery system.

Figure 18: Kalore is a hybrid composite with very low shrinkage properties.

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Figure 19: Adjusting the composite and occlusion is much easier when the patient is not anesthetized.

Figure 20: Natural coloration is an added benefit to minimally invasive and biocompatible restorative materials.

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Dr. Flax has been an Accredited Member of the AACD since 1997. He is the immediate past president of the AACD Board of Directors and is on the editorial review board of the *jCD*.

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Dr. Flax occasionally tries out products for GC America. He received no honoraria in connection with this article.

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