

A cost-effective treatment for severe generalized erosion and loss of vertical dimension of occlusion: laboratory-fabricated composite resin restorations

Michael J. Metz, DMD, MSD, MS, MBA ▪ Brandon M. Stapleton, DMD ▪ Bryan T. Harris, DMD, CDT ▪ Wei-Shao Lin, DDS

This case report describes preventive and restorative treatment planning for a 56-year-old female patient with severe, chronic, poorly controlled gastroesophageal reflux disease and resulting loss of vertical dimension of occlusion. First, the demineralization process was controlled through collaboration with the patient's physician, and measures were taken to restore adequate stimulated salivary flow. Then, for financial reasons, indirect laboratory-fabricated composite resin restorations were adhesively bonded to replace lost tooth structure and reestablish the patient's collapsed vertical dimension. Indirect laboratory-fabricated restorations can be a cost-effective alternative to direct composite resin or all-ceramic restorations for

the treatment of chronic severe erosion, but there are no long-term clinical reports in the current literature to support or contraindicate the use of indirect composites for this type of clinical application. Therefore, careful, long-term follow-up evaluations are planned for this patient.

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Dental erosion, the chemical demineralization of hydroxyapatite crystals, can present clinically in many different ways.^{1,2} Dental erosion on the lingual surfaces of the teeth has been most often associated with chronic bulimia and gastroesophageal reflux disease (GERD).^{1,2} Patients with these diseases exhibit severe lingual and/or occlusal loss of tooth structure and diminished vertical dimension of occlusion (VDO).^{1,2} It has been reported that the constant low pH (2-3) in the oral environment of these patients removes the protective salivary glycoprotein pellicle covering the hard and soft oral tissues.^{3,4} Additionally,

loss of VDO is closely associated with poor functional guidance, increased stress on the temporomandibular joint, overrotation of the meniscus, and occlusal disharmony.⁵

Case reports in the literature describe treatment of severe erosion with bonded direct composite resin or ceramic restorations.^{6,7} However, there are no long-term studies reported in the current literature to validate the choice of any one material as a gold standard. Therefore, laboratory-fabricated composite resin restorations intended as long-term interim restorations may be a viable treatment option as well. The physical and mechanical properties of

indirect composite resins have been evaluated in vitro, but there are no long-term clinical evaluations reported to date.⁸⁻¹¹ Nevertheless, laboratory-fabricated composite resin achieved the same flexural strength values as direct composite resin systems for permanent restorations.⁸ Moreover, laboratory-fabricated composite resins did not show a statistically significant loss of strength after 2 years of simulated service, while methylmethacrylate acrylic resins did.⁹

This clinical case report describes a cost-effective workflow in which laboratory-fabricated composite resin restorations permanently bonded with a self-etching



Fig. 1. Extensive erosive destruction of the teeth in a patient with chronic gastroesophageal reflux disease.



Fig. 2. Corrected VDO set on a semiadjustable articulator.

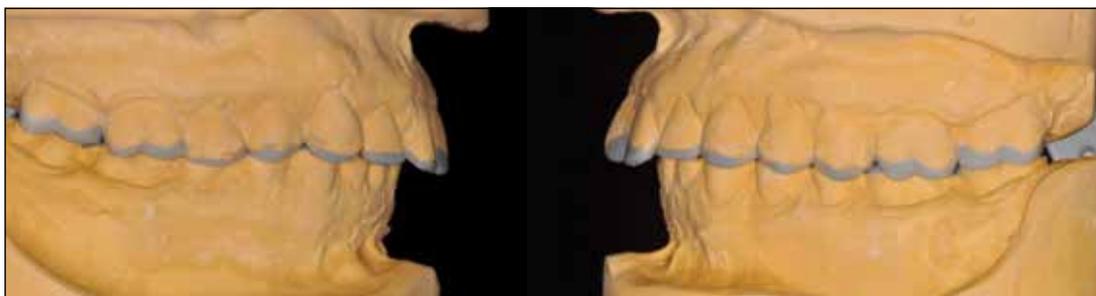


Fig. 3. Diagnostic wax-up at the corrected VDO set on a semiadjustable articulator.

dual-cured composite resin luting agent were used to replace lost tooth structure and reestablish ideal VDO in a patient with severe chronic erosion.

Case report

A 56-year-old woman who was referred by her oncologist presented to the University of Louisville, School of Dentistry, for screening to become a comprehensive care patient. Upon clinical examination and medical history review, it was determined that the patient would best be treated in the graduate prosthodontics clinic under direct supervision.

The patient had a medical history of Barrett's esophagus and had received head and neck radiation for an esophageal adenocarcinoma secondary to her chronic GERD. Although the radiation beam was precise, the left parotid, submandibular, and sublingual glands were in the field. Her lifelong battle with this disease, taking over-the-counter antacids and prescription histamine antagonists, resulted in extensive erosive destruction of her dental hard tissue (Fig. 1). Following surgical excision and head and neck radiation, she was taking proton pump inhibitors and promotility drugs.

With her disease under control, she presented for comprehensive dental treatment and a cost-effective restoration of tooth structure and VDO. The comprehensive examination included hard and soft tissue evaluations, oral cancer screening, diagnostic imaging, caries risk assessment, and periodontal evaluation. After the clinical examination was completed and study casts were mounted on a semiadjustable articulator, the patient was diagnosed with generalized advanced erosion of the dental hard tissue and loss of 4.5 mm of VDO (Fig. 2).

After evaluation of the patient's interocclusal rest space with the mandible in a relaxed position and estimation of the loss of occlusal and lingual enamel, a diagnostic wax-up was performed on the study casts to reestablish her theoretical VDO (Fig. 3). The patient had lost her anterior and posterior functional guidance and started bruxing due to the occlusal disharmony. Her periodontal status was within normal limits, and only localized gingivitis was present around the maxillary second molars.

An extensive caries risk assessment, including evaluation of the patient's salivary flow, composition, pH, and buffering (Saliva-Check BUFFER testing kit, GC

America, Inc.), was performed (Table 1). Her salivary pH was determined to be 6.2 (moderately acidic) with a low buffering capacity recorded as 6 on the manufacturer's scale (6-9, low).¹² Additionally, both *Streptococcus mutans* and *Lactobacillus* colony-forming units (CFUs) were evaluated (CRT bacteria testing kit, Ivoclar Vivadent, Inc.) (Table 2). It was determined that she had low numbers of CFUs of both *S mutans* (10^3 CFU/mL of saliva) and *Lactobacillus* (10^3 CFU/mL of saliva). Although the patient's levels of cariogenic bacteria were not determined to put her at high caries risk, her reduced salivary flow and active noncavitated white-spot demineralization placed her in the moderate to high risk category. Overall stimulated salivary flow was diminished following radiation therapy on the patient's left side (0.7 mL/min; normal rate, 1.0-1.5 mL/min). Unstimulated salivary flow was only slightly below the normal threshold (0.3 mL/min; normal rate, 0.5 mL/min).

The patient was prescribed 5 mg of pilocarpine hydrochloride, twice daily, to increase normal salivary secretions, and 1.1% neutral sodium fluoride gel to be

Table 1. Reference values for Saliva-Check BUFFER testing kit.

	Very low (red): high caries risk	Low (yellow): moderate caries risk	Normal (green): low caries risk
Stimulated flow rate	≤ 0.5 mL/min	0.6-0.9 mL/min	≥ 1.0 mL/min
Unstimulated flow rate	≤ 0.2 mL/min	0.3-0.4 mL/min	≥ 0.5 mL/min
Salivary pH	5.0-5.9 Extreme acidity	6.0-6.6 Moderate acidity	6.9-7.8 Normal acidity
Salivary buffering (manufacturer's scale ¹²)	0-5 Very low	6-9 Low	10-12 Normal

Data provided by manufacturer.¹²

Table 2. Reference values for CRT bacteria testing kit.

Organism	Low caries risk	High caries risk
<i>Streptococcus mutans</i>	< 10 ⁵ CFU/mL of saliva	≥ 10 ⁵ CFU/mL of saliva
<i>Lactobacillus</i>	< 10 ⁵ CFU/mL of saliva	≥ 10 ⁵ CFU/mL of saliva

Abbreviation: CFU, colony-forming units.
Data provided by manufacturer.¹³



Fig. 4. Indirect composite resin restorations on the master casts.

applied at home in tray carriers. With the constant insult of gastric acid removed, the increased salivary flow would provide the necessary glycoprotein pellicle and buffering to respond to routine demineralization challenges. The fluoride gel would drive remineralization of the active noncavitated white-spot demineralization and provide a more stable fluorohydroxyapatite crystal. A caries risk assessment was to be performed at each 3-month recall to evaluate the effectiveness of the salivary stimulant at maintaining a more ideal salivary flow, increasing the pH environment, improving buffering capabilities, and keeping cariogenic bacteria at bay.

The patient received a routine prophylaxis that included 4 quadrants of hand scaling and polishing. She was classified as having Class V anterior clinical erosion (ACE) on her anterior teeth. According to Vailati & Belsler, ACE Class V is characterized by extensive dentin exposure

on the palatal aspect, loss of the incisal length of the tooth (greater than 2 mm), and distinct reduction or loss of the facial enamel.¹⁴ In such cases, they suggested that the lingual aspect of the teeth be restored with composite resin veneers and the facial aspect be restored with ceramic veneers to better blend the transitions of color.¹⁴ In consideration of the patient's financial situation in the present case, the restorative treatment plan included laboratory-fabricated composite resin restorations (RADICA, DENTSPLY International) adhesively bonded with a self-etching dual-cured composite resin luting agent (Multilink Automix, Ivoclar Vivadent, Inc.) to restore form and function.

All unsupported enamel was gently removed with a No. 556 FG (friction grip) carbide bur (Brasseler USA) in a high-speed handpiece as part of a minimally invasive prosthodontic procedure described by Fradeani et al.¹⁵ Where possible, small,

nonundercut antirotation grooves were placed in the dentin with a latch head No. 2 round bur (Brasseler USA) in a low-speed handpiece. All margins were finished on solid enamel structure, and areas of demineralization were avoided.

Once the preparations were completed, maxillary lingual margins were exposed with a diode soft tissue laser (Odyssey Laser, Ivoclar Vivadent, Inc.) because there was adequate thickness of keratinized tissue. Following the surgical exposure of the maxillary lingual margins, polyether definitive impressions (Impregum, 3M ESPE) of the maxillary and mandibular arches were taken in custom trays and poured into master casts.

A facebow transfer was used to mount the maxillary relationship on a semiaadjustable articulator (8500 Series, Whip Mix Corporation). The mandibular cast was then mounted to the maxillary cast at the newly established VDO with a custom



Fig. 5. Indirect composite resin restorations after delivery.

acrylic resin bite record in centric relation. The color for the final restorations was chosen with the patient's input and determined to be C2 (VITA Shade Guide, VITA North America).

When they were returned from the laboratory, all restorations were evaluated individually and collectively on the master casts for form, function, and esthetics (Fig. 4). Once evaluated, the restorations were evaluated clinically with try-in paste (Multilink Automix Glycerin Try-in Paste, Ivoclar Vivadent, Inc.). After verification, all restorations were air abraded with aluminum oxide particles (PrepStart, Danville Materials), etched with 9% hydrochloric acid (Ultradent Porcelain Etch, Ultradent Products, Inc.), coated with Ivoclean (Ivoclar Vivadent, Inc.), and lightly coated with Monobond Plus (Ivoclar Vivadent, Inc.) on the intaglio surfaces to prepare for delivery.

Each restoration was placed individually, in a serial fashion, with a self-etching dual-cured composite resin adhesive luting agent (Multilink Automix) used according to the manufacturer's recommendations. A calibrated Bluephase LED light source (Ivoclar Vivadent, Inc.) was used to autopolymerize the resin adhesive according to the manufacturer's recommendations. Excess resin adhesive material was removed with a hand scaler after spot light curing. Once clean, each surface of the restoration was light cured for 30 seconds per side. Finally, after serial delivery was completed, all the

margins were polished with a low-abrasive composite finishing kit (OptraPol Next Generation, Ivoclar Vivadent, Inc.).

All proximal contacts were verified with unwaxed floss during serial delivery. All occlusal contacts were verified and adjusted with a FG fine football Dialite diamond (Brasseler USA) in a high-speed handpiece after all restorations were placed. All functional movements were verified and adjusted with the football bur to ensure proper anterior and posterior guidance, as requested in the original laboratory prescription.

Once all restorations were delivered and occlusal contacts and working movements were verified, the restorations were polished with a serial polishing kit and paste (OptraPol Next Generation) (Fig. 5).

The next step in the process was planning for eventual direct bonding of composite resin or ceramic facial veneers to alleviate the color discrepancy between her natural teeth and the restorations.^{14,15} The patient was placed on a 3-month recall schedule to monitor salivary flow, caries risk, and clinical integrity of the laboratory-fabricated restorations. There are no long-term clinical reports in the current published literature to support or contraindicate the use of the material chosen for her cost-effective reconstruction, so careful long-term follow-up was planned to evaluate success or failure and repair rates of this treatment.

The patient was evaluated 3 months posttreatment for functionality and muscular acceptance of the reestablished VDO. During a thorough review by a

specialist in temporomandibular disorders, the patient reported no muscular complications associated with temporomandibular disease or occlusal disharmony.

At 3 months, the parasympathomimetic salivary stimulant was producing a more normal stimulated (1.1 mL/min) and unstimulated (0.5 mL/min) salivary flow rate. The caries risk assessment indicated better buffering capacity (11) and pH (6.8, normal acidity), and the cariogenic bacteria remained low at 10^3 CFU/mL of saliva. The patient was initially classified as a moderate to high caries risk but was reclassified as a moderate risk.

None of the restorations debonded during the initial 3 months of service and none needed to be repaired. The patient will be recalled every 3 months to evaluate any problems that may arise during service.

Discussion

Patients with chronic GERD, as in the present case, exhibit severe lingual and occlusal loss of tooth structure and diminished VDO.^{1,2} Moreover, the acidic oral environment removes the protective salivary glycoprotein pellicle covering the hard and soft oral tissues.³ The glycoprotein pellicle is important in that it helps to concentrate calcium and phosphate minerals during the normal demineralization process.³ These minerals (and topical fluoride) are key to the remineralization needed after the acidic challenge is removed.³ Also reported in the literature is that large volumes of gastric acid can displace saliva due to a lower surface tension.³ A key innate component of both

stimulated and unstimulated salivary flow is the ability to buffer pH with carbonic anhydrase and phosphate during brief exposures to acidic challenges.^{3,4} The chronic combination of pellicle degradation, displaced salivary exposure, and limited salivary buffering in this patient resulted in severe, persistent demineralization that caused significant dental damage.¹⁻⁴

Loss of VDO is closely associated with poor functional guidance, increased stress on the temporomandibular joint, overrotation of the meniscus, bruxism (as seen in the present patient), and occlusal disharmony.⁵ Reestablishment of the VDO can relieve stress on the temporomandibular joint and provide the functional guidance needed for occlusal harmony.⁵

Treatment of severe erosion with both bonded direct composite or laboratory-fabricated ceramic restorations has been reported.^{6,7} RADICA laboratory-fabricated composite resin is advertised as suitable for long-term interim restorations and may be a viable treatment option as well. It is a urethane dimethacrylate-based, visible light-cured composite resin material requiring heat for manipulation and activation.

The physical and mechanical properties of indirect composite resins have been evaluated in vitro.⁸⁻¹¹ The international standard, *ISO 10477:2004*, recognized by the US Food and Drug Administration, recommends a minimum strength of 50 MPa (3-point bending, flexural strength) for provisional restorative systems.⁸ In flexural strength measurements, laboratory-fabricated composite resin showed results similar to those obtained for direct composite systems for permanent restorations.⁸ In another study, the fracture resistance of RADICA 3-unit fixed partial dentures and acrylic resin (methylmethacrylate) prostheses was evaluated in vitro.⁹ Laboratory-fabricated composite resin prostheses did not show a statistically significant loss of strength after 2 years of simulated service, while methylmethacrylate acrylic prostheses did; laboratory-fabricated prostheses retained significantly more load-bearing capability than acrylic resin prostheses.⁹

Jain et al evaluated in vitro wear of 4 commercial indirect composite resins using 3 different test methods: toothbrush abrasion wear, 3-body Alabama-type wear, and 2-body pin-on-disc wear.¹⁰

Results indicated that RADICA was not statistically significantly different from the control (hydroxyapatite), meaning that it wore similar to natural tooth structure.¹⁰ Another in vitro study evaluated the color stability, gloss, and surface roughness of 4 indirect composites.¹¹ RADICA was shown to be susceptible to extrinsic stain challenges (coffee), lose surface gloss in 2-body wear, and have an increased surface roughness in 2-body wear.¹¹

No long-term clinical evaluations of indirect composite resins have been reported to date, but a short-term clinical evaluation of 190 RADICA restorations determined that performance for provisionalization was acceptable during a service range of 3 to 67 days.¹⁶ These restorations were used as interim restorations while indirect crowns were being fabricated at local laboratories. Most of the failures were due to prepared areas where the composite resin material was thinner than the functional thickness recommended by the manufacturer, causing catastrophic failure.¹⁶ In the present case report, the minimal thickness of the material on all occlusal surfaces exposed to compressive forces was 1.5-2.0 mm, as recommended by the manufacturer.¹⁷

Adhesive bonding is crucial to the long-term clinical success of both direct and indirect composite resin restorations. A current review of the literature evaluated the resin bond to indirect composite materials.¹⁸ The most common surface treatments for the bonding surfaces were aluminum oxide air abrasion, silane treatment, and hydrofluoric acid etching for indirect composite restoration.¹⁸ The review found that self-adhesive cements achieved lower bond strengths than etch-and-rinse systems.¹⁸ However, the review consisted of only 18 articles meeting the inclusion criteria, and 1 of these criterion was that the research was an in vitro evaluation.

The authors of the present case report searched the PubMed database and found hundreds of articles comparing total-etch to self-adhesive resin cements for indirect restorations with conflicting results. The current literature is lacking a long-term randomized clinical evaluation to definitively answer this question. After a review of the conflicting literature, the group treating the patient in the present case report reached a consensus and decided to use a self-adhesive dual-cured composite resin luting agent

(Multilink Automix). The authors believe that the treatment chosen is in no way inferior to the use of a total-etch system.

If repair of laboratory-fabricated composite resin material is needed, a recent in vitro study compared the effects of 2 mechanical surface preparation techniques, air abrasion and neodymium-doped:yttrium-aluminum-garnet (Nd:YAG) laser, with the use of 2 adhesive systems—self-etching and etch-and-rinse—on the repair bond strengths of an indirect composite resin.¹⁹ It was concluded that surface preparation with either air abrasion or Nd:YAG laser resulted in a significant increase in the repair bond strength; air abrasion was more effective.¹⁹ There were no significant differences in bond strength between the two adhesives.¹⁹ If repairs of the restorations are needed in the present case, an air abrasion unit (PrepStart, 36% phosphoric acid conditioning (DeTrey Conditioner 36; DENTSPLY International), total-etch resin adhesive (XP Bond, DENTSPLY International), and nanofilled direct composite resin (Tetric EvoCeram, Ivoclar Vivadent, Inc.) will be used.

Because of financial considerations, the treatment of choice was to use a conventional polyvinylsiloxane impression technique, self-adhesive resin cement, and laboratory-fabricated indirect composite resin restorations. Another cost-effective alternative could have been the use of a direct approach with adhesive bonding of a direct composite resin restorative material. The indirect technique was chosen over the direct technique to enable collective adjustment of any functional discrepancies in the final restorations on the semiadjustable articulator prior to delivery. A third affordable treatment option could have been the use of digital scanning software to capture the final preparations, design software for design of the restorations, and computer-aided milling of prepolymerized composite resin blocks. However, the treatment selected in the present case represents a viable option for general dentists who may not have that technology in their offices.

All patients deserve clinically sound but cost-effective treatment options that will fit their financial means. It is the clinician's responsibility to research and understand the clinical applications of dental materials, including physical, mechanical, and

optical properties, in order to provide appropriate treatment options. In the present case, a new conceptual approach to treating an advanced disease process followed in-depth consideration of the aforementioned properties. However, to date, there are no clinical reports in the published literature to indicate if this concept is a viable long-term treatment option or inferior to other treatments in any way. Therefore, the patient will be monitored carefully, and a 5-year follow-up report is planned to report any failure (complete debonding) or repair during service.

Conclusion

Laboratory-fabricated composite resin restorations were permanently bonded with a self-etching dual-cured resin adhesive to replace lost tooth structure and reestablish ideal VDO in a patient with severe erosion. Long-term monitoring is planned to ensure that the restorations remain viable.

Author information

Dr. Metz is an assistant professor and vice chairman, Department of General Dentistry and Oral Medicine, School of Dentistry, University of Louisville, Kentucky, where Dr. Stapleton is a post-graduate resident, Dr. Harris is an associate professor, and Dr. Lin is an assistant professor, Department of Oral Health and Rehabilitation.

Disclaimer

The authors have no financial, economic, commercial, or professional interests related to topics presented in this article.

References

1. Uhlen MM, Tveit AB, Refsholt Stenhagen K, Mulic A. Self-induced vomiting and dental erosion—a clinical study. *BMC Oral Health*. 2014;14:92.
2. Picos A, Chisnoiu A, Dumitrascu DL. Dental erosion in patients with gastroesophageal reflux disease. *Adv Clin Exp Med*. 2013;22(3):303-307.
3. Ranjitkar S, Kaidonis JA, Smales RJ. Gastroesophageal reflux disease and tooth erosion. *Int J Dent*. 2012; 2012:479850.
4. Hara AT, Zero DT. The potential of saliva in protecting against dental erosion. *Monogr Oral Sci*. 2014;25: 197-205.
5. Wong AT, Nguyen CT. Rehabilitation of a patient with an elusive medical history and loss of occlusal vertical dimension. *J Can Dent Assoc*. 2013;79:d35.
6. Aziz K, Ziebert AJ, Cobb D. Restoring erosion associated with gastroesophageal reflux using direct resins: case report. *Oper Dent*. 2005;30(3):395-401.
7. Cengiz S, Cengiz MI, Sarac YS. Dental erosion caused by gastroesophageal reflux disease: a case report. *Cases J*. 2009;2:8018.
8. International Organization for Standardization (ISO). *ISO 10477:2004, Dentistry—Polymer-Based Crown and Bridge Materials*. Geneva: ISO; 2004.
9. Lang R, Rosentritt M, Behr M, Handel G. Fracture resistance of PMMA and resin matrix composite-based interim FPD materials. *Int J Prosthodont*. 2003;16(4): 381-384.
10. Jain V, Platt JA, Moore BK, Borges GA. In vitro wear of new indirect resin composites. *Oper Dent*. 2009;34(4): 423-428.
11. Jain V, Platt JA, Moore K, Spohr AM, Borges GA. Color stability, gloss, and surface roughness of indirect composite resins. *J Oral Sci*. 2013;55(1):9-15.
12. GC America, Inc. *Saliva-Check BUFFER* [product information]. Available at: http://www.gcamerica.com/products/preventive/Saliva_Check_BUFFER/index.php. Accessed July 6, 2015.
13. Ivoclar Vivadent, Inc. *CRT bacteria* [product information]. Available at: <http://www.ivoclarvivadent.com/en/products/prevention-care/caries-risk/crt-bacteria>. Accessed July 7, 2015.
14. Vailati F, Belser UC. Classification and treatment of the anterior maxillary dentition affected by dental erosion: the ACE classification. *Int J Periodontics Restorative Dent*. 2010;30(6):559-571.
15. Fradeani M, Barducci G, Bacherini L, Brennan M. Esthetic rehabilitation of a severely worn dentition with minimally invasive prosthetic procedures (MIPP). *Int J Periodontics Restorative Dent*. 2012; 32(2):135-147.
16. Ewoldsen N, Sundar V, Bennett W, Kanya K, Magyar K. Clinical evaluation of a visible light-cured indirect composite for long-term provisionalization. *J Clin Dent*. 2008;19(1):37-41.
17. DENTSPLY International. *Radica* [product information]. Available at: https://www.dentsply.com/content/dam/dentsply/pim/manufacturer/Prosthetics/Fixed/Provisional/Radica_Accessories/Radica-Accessories-zc9s1ce-pdf-en-1402. Accessed July 7, 2015.
18. Spitznagel FA, Horvath SD, Guess PC, Blatz MB. Resin bond to indirect composite and new ceramic/polymer materials: a review of the literature. *J Esthet Restor Dent*. 2014;26(6):382-393.
19. Kimyai S, Oskoe SS, Mohammadi N, et al. Effect of different mechanical and chemical surface treatments on the repaired bond strength of an indirect composite resin. *Lasers Med Sci*. 2015;30(2):653-659.

Manufacturers

Brasseler USA, Savannah, GA
800.841.4522, www.brasselerusa.com

Danville Materials, San Ramon, CA
800.827.7940, www.danvillematerials.com

DENTSPLY International, York, PA
800.877.0020, www.dentsply.com

GC America, Inc, Alsip, IL
800.323.7063, www.gcamerica.com

Ivoclar Vivadent, Inc., Amherst, NY
800.533.6825, www.ivoclarvivadent.com/en

Ultradent Products, Inc., South Jordan, UT
888.230.1420, www.ultradent.com

VITA North America, Yorba Linda, CA
800.828.3839, vitanorthamerica.com

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800.626.5651, whipmix.com

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