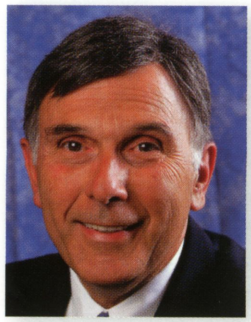
In This Section:

- Clinical Case Report: Complex Composite Resin Bonding . . . . . page 59
- Interview with the Candidate . . . . . page 67
- Newly Accredited Member . . . . . page 68



by
John A. Stratta, D.M.D.

Dr. John Stratta is a graduate of Fairleigh Dickinson University School of Dental Medicine, where is was elected into the OKU. He graduated from the New York University (NYU) School of Dentistry post-doctoral program in prosthodontics. He also served as a faculty member at the NYU School of Dentistry for 20 years. He has maintained a full-time private practice in New York focused on esthetic, prosthetic, and implant dentistry since 1965. Dr. Stratta served a 2-year tour of duty as a Captain in the U.S. Army Dental Corps as a prosthodontist. He has attained advanced training certification in gnathology, Schyler Panky Dawson traditional occlusion, implant prosthodontics, microdentistry, and esthetically based cosmetic dentistry, and is currently training in neuromuscular occlusion. He also maintains memberships in many professional societies, organizations, and academies.

Clinical Case Report: Complex Composite Resin Bonding

INTRODUCTION

The Class IV defect presents the cosmetic dentist with an esthetically challenging and restoratively demanding treatment procedure that requires insight into the following areas:[1-6]

- occlusal force distribution
- parafunctional habits
- coronal morphology
- material compatibility properties
- polychromicity
- texture
- finish line boundary camouflage
- shade selection analysis
- polymerization shade behavior shifts
- adhesive restorative materials
- polishability
- maverick colors.

The evolution of anterior restoratives from the archaic silicates and methylmethacrylate acrylics to the current generation of sophisticated composite resins and adhesives means that clinicians now have restorative materials with which to mimic the esthetic appearance of a natural tooth while simultaneously preserving, as well as reinforcing, the restored tooth.[7,8]

Treatment with such a conservative approach creates challenges in selecting and combining composite resins that chameleonize with the polychromicity of enamel and dentin. They also present an opacity challenge to simultaneously mask the existence of an internal restorative interface and the external restorative margin.[9]

Figure 1: Before, full smile frontal view, 1:2 magnification, non-retracted view.

Figure 2: After, full smile frontal view, 1:2 magnification, non-retracted view.

HISTORY

The patient is a 42-year-old male with no significant medical history. He presented with a traumatic injury to the left central incisor. The brother of a goalie for the New York Rangers, the patient had participated in a team practice session when he felt a sudden mild bumping, which would have gone unnoticed except for pieces of shattered tooth in his mouth. He experienced no pain and there was no injury to the lips or soft tissue. There was no bleeding and the tooth felt firm. His chief complaints were sharpness of the remaining tooth, a lisp when speaking, and concern for his appearance. The patient wanted to leave the office expeditiously with a natural-looking restoration.[10] The treatment option of choice was a direct resin-bonded Class IV restoration.

DIAGNOSIS AND TREATMENT PLAN

A complete examination and full series of radiographs were performed,[11] revealing five amalgam restorations, two molar porcelain-fused-to-metal crowns, the absence of carious lesions, the coronal fracture of #9, no root fracture, no periodontal ligament space thickening and a 0.5 mm thickness of dentin remaining incisally to the pulp chamber. Endodontic vitality tests with electrical, thermal, and percussive stimuli revealed positive pulpal vitality. Periodontal survey revealed a healthy periodontium.

The occlusal forces to the composite created during anterior guidance functional movements are best mitigated by directing the force vectors to the composite parallel to the remaining enamel rods.

Photographic documentation was made following the AACD Accreditation protocol with Kodak Ektachrome 100 EPN 35 mm slide film. Additionally, representative Vitapan 3D (Vident; Brea, CA) and composite shade tabs were photographed with Polaroid film for reference during treatment procedures (Figs 1–10). Maxillary and mandibular alginate impressions were made for pretreatment study casts. A Denar (Teledyne Water Pik; Fort Collins, CO) semi-adjustable facebow transfer with facial horizontal plane level allowed the casts to be mounted on a Denar semi-adjustable articulator in centric occlusion.[12] Definitive occlusal treatment was not feasible at this emergency appointment; however, an interceptive soft orthotic was possible.

The polychromicity of enamel and dentin was moderate, with the enamel being mildly opaque. This is consistent with bleaching, which has the tendency to soften and blend polychromicity.[13] The surface texture appeared smooth and worn, with slightly concave developmental grooves. There were vertical surface craze lines, which were positive to the explorer. There were multiple vertical internal enamel crazing lines of varying lengths and patterns in the left central and in the adjacent incisors. The combination of surface developmental grooves and dominant axial ridges, along with surface and internal crazing characteristics, provided a favorable condition to camouflage the external marginal finish line.[4]

Figure 3: Before, right lateral view, 1:1 magnification, retracted view.

Figure 4: After, right lateral view, 1:1 magnification, retracted view.

Figure 5: Before, left lateral view, 1:1 magnification, retracted view.

Figure 6: After, left lateral view, 1:1 magnification, retracted view.

An initial shade analysis was performed under various conditions using the Vitapan (Vident) 3D shade guide[14,15] and the chromatic chart (Fig 11) described by Vanini;[16]; and with custom, in-office fabricated tabs from several brands and types of composite with both polished and non-polished surfaces.[4]

Occlusal analysis for parafunctional effects such as wear facets, cervical and cuspal abfractions, gingival recession, exostosis development, and incisal guidance integrity revealed positive findings in a majority of these areas. There was the loss of canine-protected occlusion bilaterally with erosive posterior and anterior excursive contacts. There was slight labialization and rotation of the mandibular central incisors and left lateral which, when coupled with the parafunctional activity, could further compromise the restoration.

The occlusal forces to the composite created during anterior guidance functional movements are best mitigated by directing the force vectors to the composite parallel to the remaining enamel rods. This will be accomplished by developing the angle of the faciolingual inclination of the incisal edge so that the interface of the mandibular incisal edges with the restoration will be parallel to the rods. The lingual surface of the restoration will also be contoured so that the incline angle of the surface will similarly redirect the force. Interceptive methods will be utilized to neutralize the noxious effects of prolonged parafunctional habits. Canine-protected guidance will be re-established through the direct bonding of judiciously applied microhybrid composite to the guidance pathways of the maxillary and mandibular canines.[1] A removable occlusal orthotic will be fabricated for nocturnal bruxing protection and habit abatement.[2]

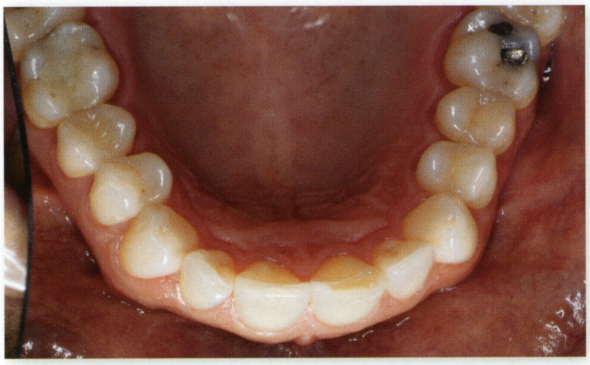


Figure 7: Before, upper arch occlusal view, 1:1 magnification, retracted view.

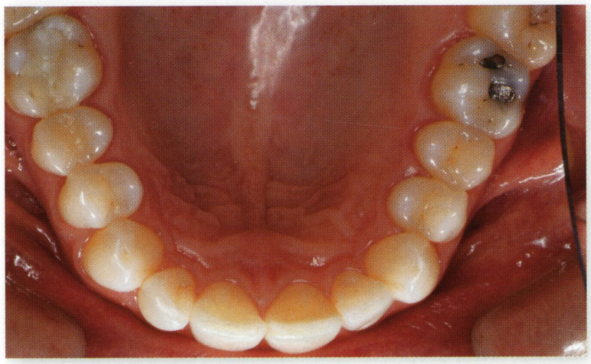


Figure 8: After, upper arch occlusal view, 1:1 magnification, retracted view.

ARMAMENTARIUM

- 37% Phosphoric acid etch Fortify (Bisco; Shaumburg, IL)
- Burs: black diamond 836-012, 849-014 (SS White; Lakewood, NJ); gold diamond 2878-313-014 (Brasseler; Savannah, GA); finishing diamonds 134F-014, 134EF-014, 134UF-014368UF-016, (Brasseler); 12 fluted ET3, ET6, OS1, OS2, carbide H282-102 (Brasseler)
- Vitapan 3D Shade Guide (Vident; Brea, CA)
- Vitalescence Shade Guide (Ultradent; South Jordan, UT)
- Composite resins: Filtek Z-250, B5, UD, A1D, IL (3M; Minneapolis, MN); Filtek A110, A1E, A2, B1 (3M); Esthet-X A-10 (Dentsply/Caulk; Milford, DE); Durafill B1, A1, A2 (Heraeus Kulzer; Armonk, NY); Vitalescence T1, PS, PF (Ultradent); Renamel Hybrid B-1, Microfill A-1 (Cosmedent; Chicago, IL)
- Articulating film (Moyco; York, PA)
- Composite placement instruments (Cosmedent): IPCL (long-bladed extra-thin), 8AL (long-bladed), Multiuse, IPCT (short-bladed extra-thin)
- Goldfogel contouring instruments (Hu-Friedy; Chicago, IL): straight -MG1, curved-MG3
- Brush #1, Resin Keeper, Flexi Buff, Enamelize (Cosmedent)
- Hollenbeck instrument, Wiedelstat chisel (Hu-Friedy)
- Ultrabrush Plus disposable brush, Jiffy brushes (Ultradent)
- Microbrush, regular, applicator tip (Microbrush; Grafton, WI)
- KolorPlus tints and opaquers (Kerr; Orange, CA)
- Creative Color tints and opaquers (Cosmedent)
- Boley gauge (Sullivan Shien; Melville, NY)
- Clearfil SE Primer and Bond (J Morita; Irvine, CA)
- Microsurgical scalpel knife (Microsurgery Institute; Santa Barbara, CA)
- Compostrips (Premier; King of Prussia, PA)
- Abrasive polishing brushes (Premier)
- Concepsis (Ultradent)
- Denar articulator, facebow (Teledyne Water Pik; Fort Collins, CO)
- Epitex finishing strips (GC; Alsip, IL)
- Sof-lex disc (3M ESPE, St. Paul, MN)
- Flexipoint cups and wheels (Cosmedent)

Manipulating composites, whether from a syringe or unit dose compule, may result in porosity.

RESTORATIVE TECHNIQUE

Special care and attention was given throughout all clinical procedures to scrupulously maintain hydration of the dentition. The teeth were supragingivally debrided of plaque, stain, and calculus with sonic scaling, powdered prophy jet, and rubber cup polishing with a slurry of Concepsis-moistened fine pumice.[3]

The initial shade selections were reconfirmed and several refinements were made. Numerous shade analysis

Figure 9: Before, frontal view, 1:1 magnification, retracted view.

Figure 10: After, frontal view, 1:1 magnification, retracted view.

TABLE 1 - SHADE OBSERVATIONS

Vitapan 3D shade guide was recorded as:

Value: 1M1 Chroma: 1L1.5 Hue: 1/2 OM1 + 1/2 1L1.5

Chromatic Chart of Vanini provided numerous categories and visual representations of the five color dimensions within teeth.[16] This chart of selections resulted in a workable nicely layered mapping, which was recorded as:

Chromicity	1/2 OM1 to 1/2 1L1.5
Value	3 – Youth- High
Intensities	1 W small white stains
Opalescence	Type 3 comb like Grey B
	Type 5 triangle mid incisal, Low chroma amber
Characterization	Type 5 vertical crack white

The final observations were made with a variety of proprietary and custom composite resin shade tabs. This provided the ability to correlate the standard ceramic convention of color units into a corresponding composite color. This conversion fine-tuned the comparison of composite color to tooth color resulting in the composite selection listed:

Filtek Z-250 Hybrid B.5, B1, UD, A1D, IL
Filtek A110 Microfill A1E, A2, B1,
Renamel Hybrid B1
Renamel Microfill A1
Vitalescence TI, PF, PS
Durafill B1, A1, A2

systems exist that attempt to communicate the variety of colors present in vital teeth.[13] A combination of three detailed systems was selected. Each proprietary system provided an accompanying prescriptive form, which facilitated organizing and tracking the color findings. The observations made with these systems are outlined in Table 1.

The visualization of restorative color is influenced by the variables found between the single tooth, contralateral teeth, the palatal intraoral dark zone, the gingival tone, the lips, the skin, and the eyes. It is possible to create a "trompe l'oeil" illusion in color and in form which, when viewed at all angles, distances, and lighting will preclude any detectable evidence of artificiality.[17]

Historically, the creation of the dental ceramic restorative illusion has been accomplished through the "ordered stratification" (as described by Geller) of colors and materials into definite discreet layers with deeper internal opaque layers, followed by serially stratified layering of increasingly translucent and transparent materials. In an important revision to this technique, known as "ordered disorder stratification," Geller recommends the placement of more translucent layers under opaque layers, as well as placing multiple opacities, colors, and translucencies discretely throughout the layers of the restoration to develop a "color contrast effect." This

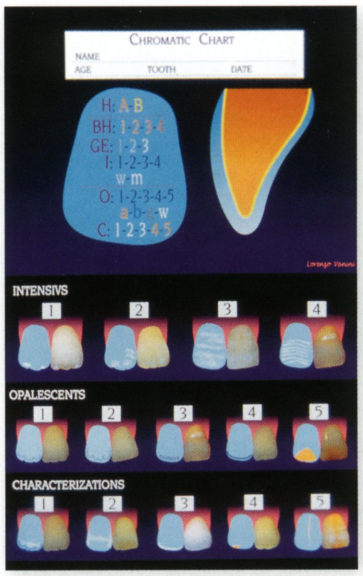


Figure 11: Chromatic chart.

facilitates the transmission of light inside the restoration, creating the real visual depth and illusionary depth characteristic of natural teeth. The objective, then, is to incorporate within the restoration a disorder of layers, hue, chroma, value, opacity, intensities, and characterizations to more closely approximate nature.[18]

Anesthesia was used and a double-layered modified rubber dam was abutted to the second premolars, exposing the teeth and gingiva while retracting the lips, cheeks, and tongue. The under-layer of rubber dam[19] was sealed to the mucosa for saliva control. The outer layer created a tension envelope between the layers to retain moistened gauze strips over the exposed non-operative teeth. These teeth were kept moistened to permit shade-matching verification during composite placement.

The unsupported enamel and damaged dentin were removed with a Wiedelstat chisel (Hu-Friedy). The distal contact was opened using a fine diamond bur and matrix band to protect the approximating surface. Anticipating the most advantageous area for creating a disappearing finish line was then evaluated. The intention was not to overstep the bounds of a Class IV and create a veneer, so a pencil outline of the intended margin was made, taking into consideration surface texture, grooves, ridges, and reverse heights of contours, which would camouflage the enamel-composite interface, reflect light into the enamel away from the visible path, and give the optimal accessibility for finishing and polishing.[3,4]

A modified chamfer-type bevel approximately 2.5 mm in width and graduating in depth from 2 mm at the fracture line to 0.2 mm at the margin, was made following the pencil outline. On the lingual surface, the margins were kept parallel to the enamel rods.

A Mylar matrix was placed to protect the adjacent proximal surfaces and 37% phosphoric acid gel was applied to the enamel for 15 seconds, to the dentin for 10 seconds, and then rinsed for 30 seconds. The excess water was absorbed by blotting with 2 mm square tissue sponges and #60 absorbent paper points, leaving a moist dentin surface. Self-etching primer Part A was applied for 20 seconds and light-cured for 20 seconds with an Optilux halogen light. The adhesive bonder Part B, a 10% filled resin, was applied and agitated with a Microbrush for 20 seconds, then air-dried for 20 seconds with a gentle dry air stream held 1 cm away. Attention was given to visually confirm the presence of a thin layer of adhesive and the absence of puddling. The Mylar matrix was removed to prevent a thick puddling of the resin at the margins and to maintain and intact the air-inhibited surface at the margin. The adhesive bonder Part B was light-cured for 20 seconds.

Manipulating composites, whether from a syringe or unit dose compule, may result in porosity. This was obviated by cutting the composite into very small increments, which were then vigorously rolled into balls on a coated pad with an alcohol-cleaned gloved finger. Inclusions such as gauze fibers, cotton dust, and other foreign bodies were also avoided. Brushes were not used to shape the composite because they increase the risk for the occurrence of inclusions, porosities, interference with the air-inhibited layer, and surface dilution by wetting agents.

The palette of composites was organized into the anticipated order of use beginning with the hybrids, followed by microhybrids and microfills. Each was arranged in a descending order of opacity, value and hue on the covered Resin Keeper (Cosmedent). The less viscous modifying opaquers, tints, and colors were arranged in the wells along with a crystal-clear unfilled resin for diluting purposes.

The initial 0.5 mm increment of high opacity and high value Z250 B.5 was placed at the pulpal floor for protection and polymerized. Additional small increments of the same hybrid shade were sequentially applied and polymerized, forming the central core of the restoration.[3,8] The core was approximately 0.7 mm in thickness, 0.7 mm short of lingual occlusion, and 0.5 mm short of incisal edge position. The lingual surface was concave inciso-gingivally to approximate the lingual anatomy, the incisal edge was

sculpted into an irregular anatomy to simulate mamelons, the facial surface had a straight emergence profile from the dentin at the juncture of the dentinal fracture line, and the internal bevel and slight hints of vertical mamelon-like grooves were sculpted. Care was taken to continuously observe the thickness and faciolingual position of the core through a mirror view to prevent overcontouring.

Throughout this operative procedure, the adjacent teeth were repeatedly referenced for value, hue, and shape comparisons by lifting the moistened gauze that maintained hydration.

Camouflaging the fracture line and raising the value of the hybrid core necessitated the use of opaquers. A thin dabbing of Creative Color A1-B1- LO Pink (Cosmedent) with a #1 brush was spotted over the tooth-composite interface and polymerized. KolorPlus A1 (Kerr) was then similarly spotted to create variation in value and chroma. These opaquers were not applied as total cover layers; rather, they were applied lightly and in a spotty manner and polymerized in multiple applications to mimic stratification.[3,4]

Esthet-X A1 (Caulk) was placed over the lingual of the Z250 central core and polymerized. The core was completed incisally with the addition of small increments of Vitalescence T1, PS, and PF (Ultradent), resulting in a mildly discernable incisal demarcation of the various shades. The high value PS shade of composite was placed at the linguo-incisal edge forming the incisal halo. The middle one-third of the opaqued core was then thinly layered with Z250 UD. Renamel Hybrid B1 (Cosmedent) formed the lingual half of the contact area. Small increments of Z250 A1 and B2 were placed, followed by another thin spotting of KolorPlus A1 opaquer. Observing the restoration from a mirrored incisal view revealed that it encompassed only one-half of the available facial lingual thickness.

The initial enamel layer was applied as a blend of Filtek A110 microfill A1 and A2 (3M), and a thin coating of Creative Color honey yellow tint (Cosmedent) was applied to the mid-incisal area. Small white intensity spots at the mesial and distal line angles were created by the application of diluted KolorPlus white opaque. The fine craze lines were created by forming an extra-thin groove in the cured microfill with a microsurgical scalpel blade, into which was placed a minute amount of diluted KolorPlus white and ochre tints. The surface enamel layer was created with extremely small pellet-like amounts of Durafill shades B1, A1, A2 (Heraeus Kulzer); and Filtek A110 shades A1 and A2E (3M), utilizing their differences in opacity and value to create a stratified effect.[20]

FINISHING

Throughout this operative procedure, the adjacent teeth were repeatedly referenced for value, hue, and shape comparisons by lifting the moistened gauze that maintained hydration. This made it possible to immediately predict the result of the restorative procedures by eliminating the necessity to wait for rehydration. The restoration was carefully examined, then extensive additional polymerization was accomplished to ensure maximum conversion of the composite resin.

The rubber dams and gauze strips were removed. First, centric occlusion functional contacts were developed using blue articulating film. Then protrusive functional slides were marked with red articulating film and adjusted into harmony with the neighboring anterior teeth. These adjustments were made with a 12 fluted OS1 bur (Brasseler). The facial surface was smoothed with 12 fluted ET3 and ET6 burs and the incisal edge was smoothed with a fine Sof-lex disc (3M ESPE). The composite surfaces extending 0.5 mm beyond the margins were etched for 10 seconds, rinsed, dried, and coated with a protective layer of Fortify (Bisco). To allow for complete development of the enamel/dentin bond strengths and for maturation of composite polymerization strength, the patient was instructed to return in 2 days for final finishing and polishing.

The first step at the finishing and polishing appointment was to contour the overall shape with the use of 12-fluted ET3, ET6 burs, as well as medium and fine Sof-lex discs. The second step followed with the careful shaping of the distal contact area to create adequate embrasure form and line angles. This was accomplished by placing a separating wedge and carving into the embrasure and proximal line angles with a microsurgical scalpel and a #12 scalpel. The wedge was removed and proximal stripping, shaping, and polishing was accomplished with an extra-fine metal strip followed by Epitex strips (GC) progressing from medium to superfine. The third step

involved the marginal interface of enamel to composite, requiring truly concentric rotary instruments free of chatter, sharp instruments, and keen observation of the existing anatomy. The locations of grooves and ridges were highlighted by pencil marks on the enamel and carved into the composite. The contouring and carving extending the anatomy into the composite was done with 12- and 30-fluted pointed, flame-shaped, and football-shaped carbide burs. Carbides were used because they impart characteristic subtle secondary facets in the microfill composite, which at the polishing stage will be made to resemble tertiary texture and provide light-reflecting surfaces.[4] Ultra diamond burs, which are more easily controlled, result in a more matted flat surface devoid of texture. In the fourth step, the primary anatomy (grooves and ridges), secondary anatomy (facets), and tertiary anatomy (texture, cracks, and crazes) are carried incisally from the margin into the body of the restoration. The same instrumentation was employed as was utilized in step three.

The fifth step addressed the incisal edge and lingual surface anatomical morphology. The final length adjustment to the incisal edge and embrasures was made by closely observing the contralateral central. The incisal edge was trimmed to coincide with the incisal guidance in a faciolingual inclination. A wear facet irregularity was located to reflect similar wear patterns on other teeth. In incisal mirror view, the facial surface anatomy was evaluated and the faciolingual width of the incisal edge was compared to the adjoining central and reduced from the lingual. The cingulum, lingual groove, and marginal ridges were carved and contoured with 12-fluted ET3, OS1, OS2 burs and were refined with ultra-diamonds.

Finally, the sixth step was polishing. The most common definition of polishing, yet the least desirable, is to obtain a high luster by developing a flat surface. True esthetic polishing results in multifaceted high-luster surfaces that maintain the subtle features of primary, secondary, and tertiary anatomy. The microfill surfaces were polished with Cosmedent blue and pink rubber points and cups, followed by a cylindrical goat's hair brush to reach the tertiary anatomy and enamelize paste on a felt-sided Flexi Buff (Cosmedent) run at a very high speed. The microhybrid which formed the lingual surface was polished with Flexipoint cups and wheels (Cosmedent), followed with a Jiffy polishing brush (Ultradent) for final high-gloss polish.

SUMMARY

Composite breakthroughs give the clinician state-of-the-art materials with which to create predictably functional and esthetic Class IV restorations. However, the ultimate esthetic result will not be achieved without implementation of a proper protocol. This case demonstrates a very specific stepwise method to implement a predictable methodology for the incremental application of varying composite resins and modifiers in a disordered stratification to transform a Class IV fracture into a final restoration that mimics nature and is in harmony with the total dentition.

For the cosmetic dentist, exquisite esthetics is a reachable quest.

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