DIRECT RECONSTRUCTION OF THE MAXILLARY ANTERIOR DENTITION WITH COMPOSITE RESIN: A CASE REPORT

Douglas A. Terry, DDS*

Direct composite restorations continue to be a viable treatment alternative for numerous patients who desire anterior reconstructive procedures. In order to achieve optimal aesthetic and functional results, the clinician must possess a thorough understanding of composite resins and color and be able to simulate the optical properties of a natural tooth. This paper describes a sophisticated polychromatic color layering technique through the correct implementation of composite materials and freehand bonding techniques for the fabrication of ten direct resin veneer restorations in the maxilla.

Key Words: composite resin, direct, color, veneer, anterior

Patient demand for aesthetic dentistry with minimally invasive procedures has resulted in the extensive utilization of freehand bonding of composite resin to anterior teeth.[1] In order to achieve a functionally successful and natural-appearing direct composite restoration, the clinician must have a comprehensive knowledge of adhesive dentistry, including the properties of composite resins, proper tooth preparation techniques, the optical properties of the natural tooth, and the four dimensions of color. The objective of this article is to demonstrate the polychromatic layering of color through the correct implementation of materials and techniques to fabricate ten direct resin veneer restorations for the maxillary anterior dentition (Figure 1).

*Clinical Assistant Professor, University of Texas Health Science Center, Houston, Texas; private practice, Houston, Texas.

Douglas A. Terry, DDS
12050 Beamer
Houston, TX 77089

Tel: 281-481-3470
Fax: 281-484-0953
E-mail: dterry@dentalinstitute.com

Due to the variety of microfilled and microhybrid composite materials that are presently available, the selection of an appropriate system may appear daunting. Nevertheless, the development of microfilled and microhybrid resins has been a useful advancement in the field of aesthetic dentistry. This advancement allows for the replacement of enamel and dentin with a material that mimics the physical and optical properties of enamel and dentin as effectively as porcelain, but with less invasive preparation.[2] These advances in material and adhesive technology result in improved bond strengths that facilitate the use of direct bonding for the intraoral fabrication of restorations that are clinically indistinguishable from the natural dentition.

Chairside modification of porcelain restorations is essentially limited to the alteration of anatomical contours and extrinsic staining. Any modification of the porcelain must be returned to the laboratory for correction. State-of-the-art freehand bonding techniques in anterior restorations can be provided chairside, however, through the use of freehand bonding techniques.

Figure 1. Preoperative facial view of the patient demonstrates the existing unaesthetic composite resin restorations.

Color

The definition of color, as related to physics, does not have the same measurable significance when applied to art. Since the compositional and emotional effects of color cannot be rationally measured,[3] knowledge of color and the different optical properties of the components of the tooth must be developed by each clinician. A fundamental comprehension of the color of natural teeth is critical in the consistent selection of appropriate shades of restorative materials.[4] As form can be described in the three dimensions (ie, height, length, and width), color has been divided into four dimensions: hue, chroma, value, and translucency.[5-7]

Hue is commonly understood as the "name" of a color, or "the basic color of an object" (eg, blue, green, yellow).[8] Hue corresponds to the wavelength of light reflected from an object. In dentistry, color is represented by shade systems (3D-Master, Vident, Brea, CA) or with designations of A, B, C, or D in accordance with a variable scale (Vita, Vident, Brea, CA). The A shades are reddish brown, the B shades are orange-yellow, the C shades are greenish gray, and the D shades are pinkish gray. In direct resin bonding, the hue is primarily determined by the selection of the "artificial dentin" or the underlying substrate. The hue of a tooth should always be performed under appropriate illumination with color-corrected light (~5000 K).[9]

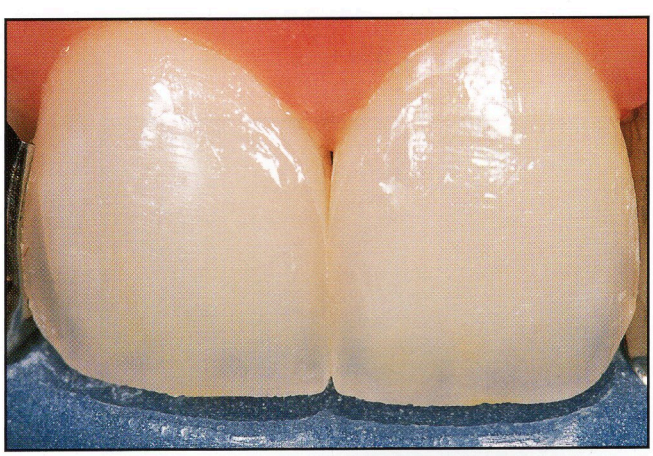

Figure 2. The maxillary central incisors are prepared to a preformed acrylic matrix.

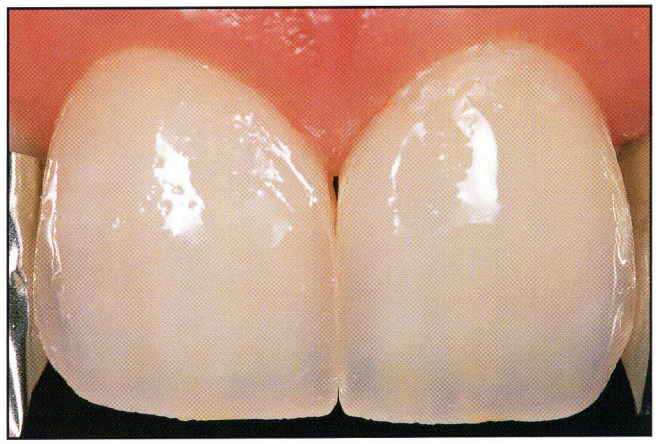

Figure 3. The initial "artificial dentin" body is applied to the teeth with a composite instrument and smoothed with a sable brush.

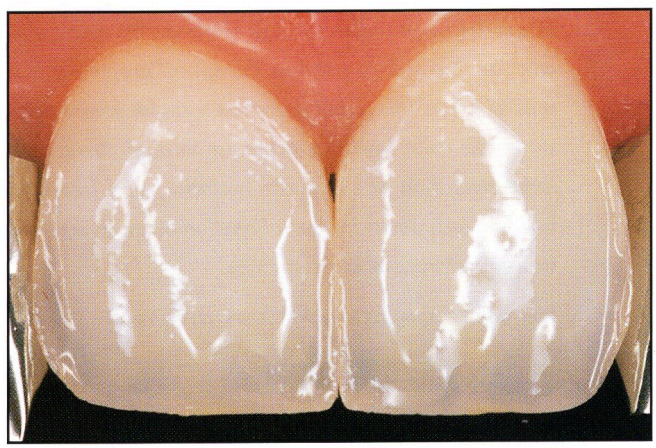

Figure 4. The incisal length was developed on the acrylic matrix utilizing hybrid composite material in order to form the dentin lobes.

Chroma can be defined as the intensity of a color or the "degree of hue saturation." In the aforementioned color scale, chroma is differentiated by various shades within a set of hues (eg, A-1, A-2, A-3, and A-4). The function of the chromatic dimension is to facilitate the comparison of colors of equal hue.[10] While identical hues are frequently found at the middle and cervical thirds of a tooth, distinct hues can be identified at the incisal third due to the way light is refracted, reflected, absorbed, and transmitted. Chroma can be varied in the utilization of internal characterization through the use of modifiers and tints. This variation can be visualized around dentinal lobes and extended to the proximal aspects of the middle third, predominantly imparting bluish or grayish hues.[11]

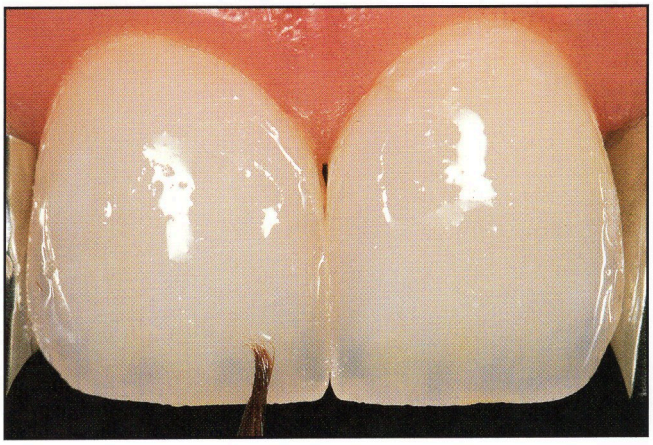

Figure 5. Internal characterization was achieved by applying tints. Note the translucency at the incisal corners.

Figure 6. Once the tints had been applied, the composite resin was rolled into a ball to permit placement on the cervical aspect of the tooth.

The most important of the four color dimensions is value,[9] which distinguishes light from dark colors. The value can be defined as the "brightness" of color.[10] The selection and variation of the composite resin that reproduces the "artificial enamel layer" is a principal determinant of the value of a restored tooth.

The final dimension of color is translucency, although this concept is difficult to explain and quantify.[9] Nevertheless, translucency significantly affects the aesthetic, vital appearance of the tooth. The degree of translucency is determined by the amount of light that penetrates the tooth or the restoration prior to being reflected externally.[10]

According to previous reports, the dentin imparts all the color of a tooth (ie, determines its hue and chroma),[12] and the enamel acts as a fiberoptic structure that conducts light through its rods to capture this color (ie, is a determinant of value).[11] Variations in the dentin thickness and the degree of translucency at different regions on the tooth impart the characteristics of polychromatism. By understanding the basic concepts of color as they are affected by the morphology of the tooth, the clinician may select composite resins that produce restorations with a more natural appearance.

Preoperative Procedure

Prior to initiating the restorative procedure, a waxup was performed on a diagnostic model of the patient's dentition. This model was used as an instructional aid for the patient and for the fabrication of a custom acrylic intraoral template that was used to guide the accurate reproduction of the desired morphology of the teeth. Preoperative photographs were taken to facilitate analysis of the smile line. Since dehydration of the teeth results in an elevated value and may cause the selection of an incorrect shade, shade selection was performed and reviewed with the patient prior to rubber dam isolation.[13]

Once the analysis had been completed, it was necessary to select the appropriate composite material for the procedure. An ideal composite resin should provide color stability, polishability, and sculptability; it should also endure functional stress and produce optimal aesthetics. As no single composite resin fulfills all these requirements,

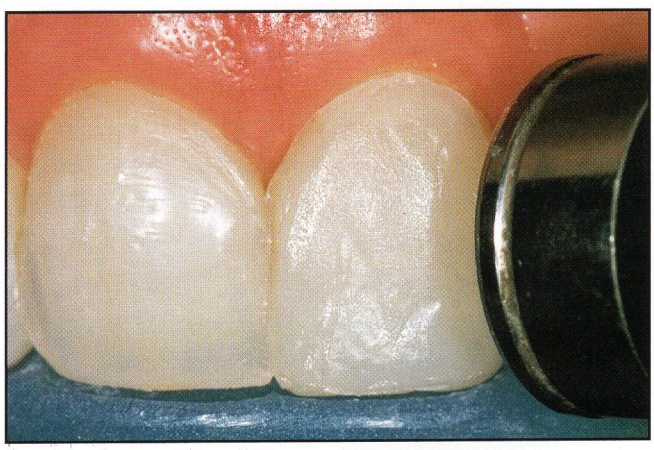

Figure 7. The surface layer of the composite material was sculpted to simulate the enamel layer. A curing light was applied to achieve polymerization.

it is necessary to select different composite materials for the "artificial enamel" and the "artificial dentin" layers.[13] Accordingly, materials that offer the widest range of colors (eg, XRV Herculite, Kerr/Sybron, Orange, CA; Vitalescence, Ultradent, South Jordan, UT; Renamel, Cosmedent, Chicago, IL) can be successfully utilized in anatomic stratification techniques.[1]

Clinical Procedure

Once anesthesia had been administered to the patient, the teeth were isolated with a rubber dam to protect against contamination. The veneer preparations were performed by using diamonds with gauged depths (Nixon Depth Cutting Burs, Brasseler USA, Savannah, GA). A long, tapered diamond was subsequently utilized to connect a series of vertical grooves along the facial surface in order to provide uniform reduction of the facial surfaces.[14] A cervical chamfer 0.3 mm in depth was placed supragingivally following the free gingival margin from papilla tip to papilla tip (Figure 2). The lingual aspect of the chamfer was extended 2 mm onto the lingual surface, but not on the occlusal contact area.[15] The preparations were completed with a finishing disk and polished with rubber cups that contained a premixed slurry of pumice and 2% chlorhexidine (Consepsis, Ultradent, South Jordan, UT). The preparations were rinsed and lightly air dried, and a soft metal strip was placed interproximally to isolate the prepared tooth from the adjacent dentition. The "total etch" technique was utilized due to its ability to minimize the potential of microleakage and enhance bond strength to dentin and enamel.[16-18] The preparation was etched for 15 seconds with 37.5% phosphoric acid gel, rinsed for 15 seconds, dried for 5 seconds, and lightly air thinned to avoid desiccation. The dentin and enamel were remoistened with water on a cotton pellet. Once a hydrophilic adhesive agent (OptiBond, Kerr/Sybron, Orange, CA) was applied, the excess was removed with the same applicator, and the agent was light cured for 30 seconds. Although a small amount of excess adhesive can be applied over the margins to improve sealing, this excess should be removed during finishing procedures in order to avoid adverse periodontal sequellae.

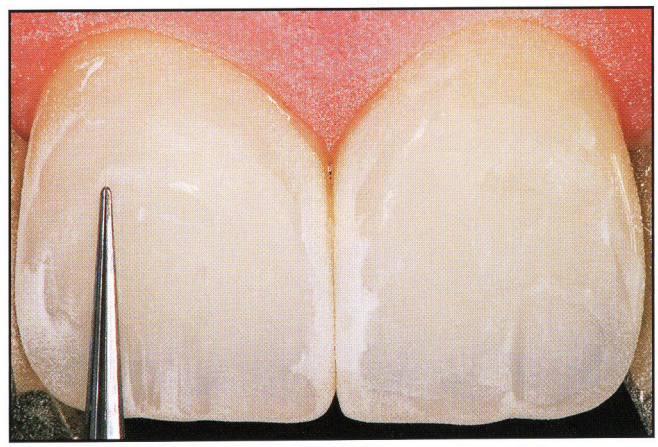

Figure 8. Facial contouring was performed with #8 and #16 fluted burs (ET-9, Brasseler USA, Savannah, GA).

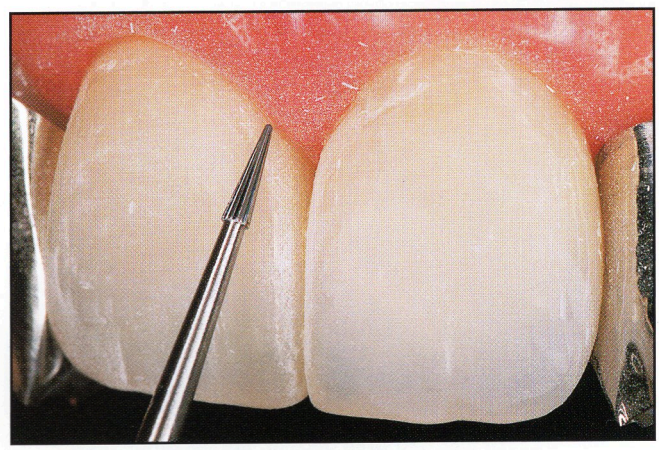

Figure 9. Gingival and interproximal contouring and finishing were also completed using #8 and #16 burs, respectively.

Figure 10. The teeth were subsequently polished to a high luster using disks. Note that the existing texture and surface anatomy were preserved throughout this process.

Figure 11. The interproximal regions were polished with paste and aluminum oxide finishing strips (Enamelize and FlexiStrips, Cosmedent, Chicago, IL).

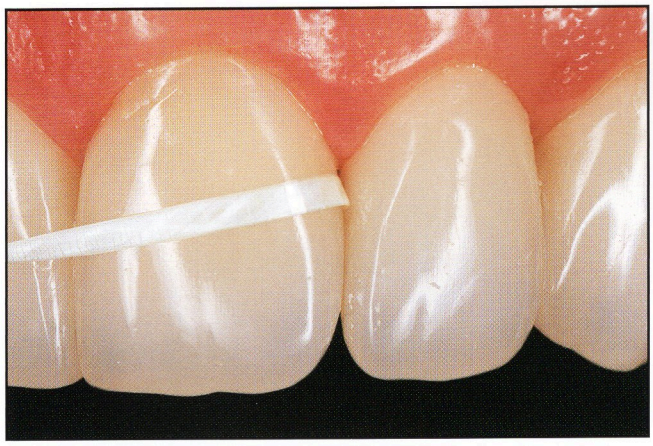

Figure 12. Dental floss was utilized to verify adequate contacts and the absence of gingival overhangs.

Figure 13. Facial view of the completed veneer restorations on the acrylic matrix.

Development of the Dentin Layer

The first layer — the artificial dentin body — of A-1 shaded composite resin (XRV Herculite, Kerr/Sybron, Orange, CA) was applied and contoured with a short-bladed composite instrument and smoothed out with an artist's sable brush (Figure 3). Since surface irregularities could have interfered with placement of the tints for internal characterizations, this step was crucial. This process was repeated with a second layer of hybrid composite to form the dentin lobes (Figure 4). In order to prevent overbuilding of the artificial dentin layer, it is imperative to constantly monitor the composite material from the incisal aspect; such an overbuilding does not allow sufficient space for the final "enamel" layer of microfilled resin. Each increment was polymerized with a curing unit (Optilux 500, Demetron, Danbury, CT) for 10 seconds, which allowed placement of subsequent increments without deforming the underlying composite layer.

To alter the chroma, a honey-yellow tint (Creative Color, Cosmedent, Chicago, IL) was thinned with clear liquid resin and applied in a thin wash at the gingival one third and gradually faded out at the incisal edge of the body layer. The areas underlying the mesial and distofacial line angles were highlighted with a diluted white modifier; the honey-yellow mix was used again to tint the surfaces lingual to these lines. These techniques utilize color variation to emphasize the tooth form and instill the restoration with a three-dimensional effect. A thick layer of the aforementioned mixture was applied to the canines to match the higher chroma of these two teeth. This process established the hue and chroma of the dentinal portion of the veneers.

Internal Color Characterization

In order to re-create the natural translucency of the enamel, a blue tint was thinned 20% with clear liquid resin and applied in a very thin wash vertically at the mesial and distal line angles; increased emphasis was placed on the incisal corners of the restorations to simulate translucency (Figure 5). This modifier was applied vertically at the incisal edges of the composite structures between the projected dentin lobes to emphasize the latter structures. A mixture of 40% white color modifier,

10% honey yellow, and 50% clear liquid resin (Creative Color, Cosmedent, Chicago, IL) was then applied vertically at the incisal edge of the tips of the dentin lobes to accentuate their presence.

Development of the Enamel Layer

The artificial enamel was restored with incisal light microfill composite resin (Renamel, Cosmedent, Chicago, IL) to achieve the proper value of the restoration. The resin was rolled into a ball and placed on the cervical region of the tooth (Figure 6). Using the short-bladed composite instruments, the composite material was sculpted and adapted to obtain an anatomically correct emergence profile that encased the underlying matrix cervicoincisally and mesiodistally (Figure 7). The microfilled resin was spread over the entire facial surface, and the final layer was slightly overcontoured to allow sufficient thickness for contouring and polishing.

Finishing and Polishing

The initial contouring was performed with a series of finishing burs in order to replicate natural form and texture.[1] The facial contouring was initiated with #8 and #16 fluted burs (ET-9, Brasseler USA, Savannah, GA) (Figure 8). The gingival and interproximal contouring and finishing were completed with #8 and #16 fluted burs respectively (Figure 9). The lingual surfaces were contoured with #8 and #16 fluted burs (OS1, Brasseler USA, Savannah, GA).

Once preliminary contouring was completed, finishing strips (FlexiStrips, Cosmedent, Chicago, IL) were used in the interproximal region; finishing on the proximal, facial, and incisal angles was performed with aluminum oxide disks (Flexidiscs, Cosmedent, Chicago, IL) and finishing strips (FlexiStrips, Cosmedent, Chicago, IL). These were used sequentially according to the grit and ranged from coarse to extra fine. For characterization, finishing burs, diamonds, and rubber wheels and points were used to create similar indentations, lobes, and ridges. Ultrafine polishing disks were used to impart a high luster while maintaining the existing texture and surface anatomy (Figure 10). Each restoration was subsequently polished for 30 seconds with paste on a moistened rubber prophy cup. Superfine finishing strips were used with polishing paste (Enamelize, Cosmedent, Chicago, IL) to refine the interproximal regions (Figure 11).

Figure 14. Postoperative buccal view of the maxillary right dentition. Note the enhanced contour of the restorations.

Figure 15. Buccal view of the maxillary left dentition postoperatively. The harmonious integration of form and aesthetics are evident.

The interproximal areas were examined with dental floss to verify adequate contacts and the absence of gingival overhangs (Figure 12). In order to evaluate occlusion, the patient was asked to first perform closure without force and then centric, protrusive, and lateral excursions. Any necessary equilibration was accomplished with a finishing bur. The overall aesthetics of the patient were evaluated and included analysis of shade, contour, facial anatomy, texture, and smile line (Figures 13 through 17). The postoperative result achieved through the use of

Figure 16. Postoperative facial view of the restored central incisor teeth. Note the optical characterizations achieved utilizing the direct bonding technique.

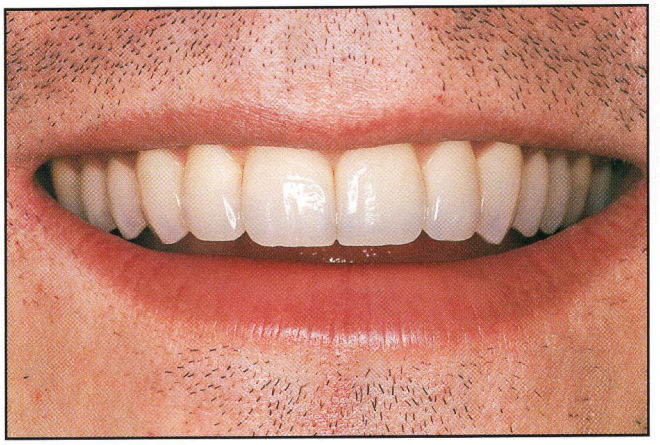

Figure 17. Postoperative facial view of the direct composite restorations. The shade, contour, and texture of the restored teeth achieved the aesthetic expectations of the patient.

the maxillary anterior composite veneers reflects the harmonious integration of form, function, biocompatibility, and aesthetics.[19]

Conclusion

Advances in material technology and adhesive dentistry have enabled the development of freehand bonding techniques that allow the provision of conservative treatment.[13] In this case presentation, a composite layering technique was combined with proper finishing protocols to achieve restorations that were harmonious with the opposing dentition.[20] This treatment was necessary not only to modify the dimensions (eg, size, form) of the teeth, but also to utilize the existing dentin for the color of the restorations. The four dimensions of color were developed in the underlying dentin with the incremental layering process. The combination of the maverick colors and the existing dentin color projected through the artificial enamel as a "composite tooth color."[12]

Direct composite restorations continue to be an efficacious means for restoring various anterior conditions.[21] Clinicians may apply their knowledge of color to select and place composite resin to create bonded resin veneers that closely simulate the optical properties of a natural tooth, thus preserving the direct-bonded resin option as a valuable treatment modality.

References

1. Dietschi D. Free-hand composite resin restorations: A key to anterior aesthetics. Pract Periodont Aesthet Dent 1995;7(7):15-25.
2. Miller M. Microfills. In: Reality 1998. 12th ed. Houston, TX: Reality Publishing, 290.
3. Rinn LA, Koehler HM, trans. The Polychromatic Layering Technique: A Practical Manual for Ceramics and Acrylic Resins. Carol Stream, IL: Quintessence Publishing, 1990:21-30.
4. Heymann HO. The artistry of conservative esthetic dentistry. J Am Dent Assoc 1987;Special No:14E-23E.
5. Baratieri LN, Andrada MAC, Montiero S Jr. et al. Dentistics-Procedimentos Preventivos e Restauradores. 2nd. ed. Sao Paulo, Brazil: Quintessence Publishing, 1992.
6. Clark EB. Tooth color selection. J Am Dent Assoc 1933;20:1065-1073.
7. Miller A, Long J, Cole J, Staffanou R. Shade selection and laboratory communication. Quint Int 1993;24(5):305-309.
8. Sproull RC. Color matching in dentistry. I. The three-dimensional nature of color. J Prosthet Dent 1973;29(4):416-424.
9. Touati B, Miara P, Nathanson D. Esthetic Dentistry & Ceramic Restorations. London, UK: Martin Dunitz, 1999:39-60.
10. Baratieri LN. Esthetic Principles [in Portuguese]. Sao Paulo, Brazil: Quintessence Publishing, 1998:48.
11. Fahl N Jr, Denehy GE, Jackson RD. Protocol for predictable restoration of anterior teeth with composite resins. Pract Periodont Aesthet Dent 7(8):13-21.
12. Muia PJ. Esthetic Restorations: Improved Dentist-Laboratory Communication. Carol Stream, IL: Quintessence Publishing, 1993.
13. Fahl N Jr. Predictable aesthetic reconstruction of fractured anterior teeth with composite resins: A case report. Pract Periodont Aesthet Dent 1996;8(1):17-31.
14. Mopper KW. Renamel restorative system clinical brochure. Cosmedent, Inc. 1994.
15. Miller M. Direct/indirect resin veneers. In: Reality 1998. 12th ed. Houston, TX: Reality Publishing, 625-633.
16. Kanca J. Improving bond strength throughout etching of dentin and bonding to wet dentin surfaces. J Am Dent Assoc 1992;123(9):35-43.
17. Nakabayashi N, Nakumura M, Yasuda N. Hybrid layer as a dentin-bonding mechanism. J Esthet Dent 1991;3(4):133-138.
18. Kanca J III. Resin bonding to a wet substrate. II. Bonding to enamel. Quint Int 1992;23(9):625-627.
19. Nixon RL. Mandibular ceramic veneers: An examination of diverse cases integrating form, function, and aesthetics. Pract Periodont Aesthet Dent 1995;7(1):17-26.
20. Fahl N Jr. The aesthetic composite anterior single crown restoration. Pract Periodont Aesthet Dent 1997;9(1):59-70.
21. Nash RW. Freehand composite veneering — The direct option. Pract Periodont Aesthet Dent 1994;6(3):89-92.