Direct Extrinsic Characterization

Maximizing Esthetics of Fixed Interim Restorations

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Abstract

Anterior fixed interim restorations fabricated in a direct fashion often lack customized characteristics inherent to the adjacent natural dentition. The purpose of this article is to demonstrate a protocol that has been optimized to enable the clinician to extrinsically characterize interim restorations in a time-efficient and predictable manner, giving the clinician the ability to integrate interim restorations into the surrounding natural dentition. This procedure aids in delineation of the patient's esthetic expectations. The customized interim restoration(s) subsequently can serve as a valuable communication tool between the clinician and patient, and aid in directing the ceramist in fabrication of the characterized definitive restoration.

Key Words: esthetic technique, provisionals, communication

CE CREDIT

Learning Objectives:

After reading this article, the participant should be able to:

1. Understand the indications and rationale for direct external custom characterization of fixed provisional restorations.
2. Understand the advantages and applications that contemporary light-curable resin modifiers offer to the clinician when emulating natural dentition characteristics for provisional restorations.
3. Be aware of the role that custom characterization can play in enhancing communication with both the patient and ceramist during the provisionalization process, leading to more predictable results in the definitive restoration(s).

"A meticulously fabricated interim restoration guides not only the clinician, but also shapes patient expectations and directs the ceramist in fabrication of the definitive restoration."

Introduction

It is often acknowledged that one of the most challenging tasks in restorative dentistry is the restoration of a single tooth or implant in the esthetic zone to a level of esthetic imperceptibility. Paramount to achieving optimal esthetics in the definitive restoration is the prerequisite fabrication of an interim restoration that aids in establishing the intended esthetic parameters.[1,2] A meticulously fabricated interim restoration guides not only the clinician, but also shapes patient expectations and directs the ceramist in fabrication of the definitive restoration.[3,4]

It has been demonstrated in health care that matching treatment outcomes to patient expectations has a direct correlation to both patient satisfaction and behavioral markers.[5] Thus, interim customization via characterization aids in establishing and fulfilling patient expectations from the initial phases of treatment and promotes psychological confidence and well-being. Despite techniques available to the clinician to develop the proper emergence profile, coronal form, primary and secondary texture, and hue in a direct interim restoration, reproducing more nuanced characteristics or other natural atypical idiosyncrasies inherent to the surrounding dentition can be a significantly greater challenge.

Techniques for Interim Fabrication

Techniques available to the clinician for interim fabrication include indirect, direct/indirect, and direct methods.[6]

Indirect Methods

Indirect interim fabrication often is advantageous in applications where multiple interim restorations are required.[7] This method of interim fabrication offers the clinician more efficient use of chair time, as well as improved material physical properties when utilized for extended treatment timeframes.[8,9] Characterization of indirect interim restorations can be achieved via additive or subtractive methods. Additive methods often employ the stratification of different hues, opacities (i.e., dentin, enamel, translucent), and modifiers of self-cure acrylics or resins to obtain the desired effect. Subtractive methods—such as the indirect sandwich technique, whereby dentin-shaded self-cure acrylics are cut back from full contour, characterized internally where indicated, and veneered with a more translucent enamel layer—represent an alternative approach.

Direct/Indirect Methods

Direct/indirect interim fabrication, typically utilized for either single- or short-span multiple-unit cases, involves both laboratory (indirect) and clinical (direct) procedures to fully develop interim restoration parameters. Custom characterization of such interim restorations can be achieved internally, during the reline procedure, or via cut-back techniques with the application of tints and modifiers followed by translucent resin.

Direct Methods

Direct methods of interim fabrication often are the most readily employed technique for fabrication of single or short-span restorations. Direct approaches include the employment of either over-impression templates from diagnostic models, wax-ups, or preformed shells that are relined upon preparation of the tooth or interim implant abutment.

Adult patients' demand for esthetically harmonious and characterized interim restorations likely will increase, given that they have been the direct beneficiary of modern preventive dentistry[10] and are increasingly more esthetically demanding.[11] Such patients may present to their dentist in need of their first single-unit implant or crown in the midst of a natural, albeit characterized, anterior dentition. Many current techniques utilized for the direct fabrication of interim restorations do not adequately address intraoral techniques for interim characterization; therefore, this important esthetic parameter often is overlooked.

Custom Characterization

Efforts have been made in the past to develop predictable protocols for custom characterization of fixed interim restorations. Using a direct/indirect ap-

proach, some have advocated the incorporation of modifier acrylic resins into a preformed shell, which is subsequently relined with an autopolymerizing acrylic.[12,13] Others have advocated direct approaches to customization at full contour using acrylic powder stains compatible with self-cure acrylics, polycarbonate shell materials, and cellulose acetate matrices.[14-16] Reports of using finely shaved colored chalk on either the powder or base of temporary cements has also been proposed to customize the color of the interim restoration.[17]

Each of these techniques suffers from a lack of fine control over the degree and extent of characterization incorporated. Preformed shells customized internally require more time-consuming modifications if the patient or clinician is not satisfied with the proposed characterization upon reline; thus, the clinician may become discouraged by the lack of predictability offered by such a workflow. Acrylic stains suffer from lack of standardization, based upon the powder-to-liquid ratios, as well as an inability to have temporal control over stain localization due to autopolymerization properties. In addition, powder-liquid acrylics often lack color stability when utilized for extended treatment periods.[18]

Light-curable resin color modifiers, on the other hand, are compatible with increasingly popular bis-acryl interim materials. Resin color modifiers enable the clinician to have full temporal control over stain localization via light-curing capability, and offer flexibility to modify the stains by physical removal and incremental re-bonding, if desired. These modifiers also offer the ability to seal the bis-acryl interim cavosurface, offering the additional benefit of improved stain resistance.[19] To date, there is a paucity of literature available demonstrating contemporary techniques to enable the clinician to directly custom characterize a full-contour interim restoration in a predictable and time-efficient manner.

Case Report

Diagnosis

A 25-year-old male was referred to the University of Iowa College of Dentistry for evaluation and treatment of a suspected vertical root fracture of the maxillary right central incisor **(Fig 1a)**. The clinical examination and subsequent removal of the existing crown confirmed the vertical root fracture and hopeless long-term prognosis **(Fig 1b)**; after discussing treatment options with the patient, a single-tooth implant replacement strategy was chosen. The patient expressed his desire to idealize the symmetry of the central incisors at the time of fabrication of the definitive implant-supported restoration to enhance his anterior esthetics.

Figure 1a: Initial clinical presentation of patient with marginal inflammation and fractured incisal porcelain on the maxillary right central incisor.

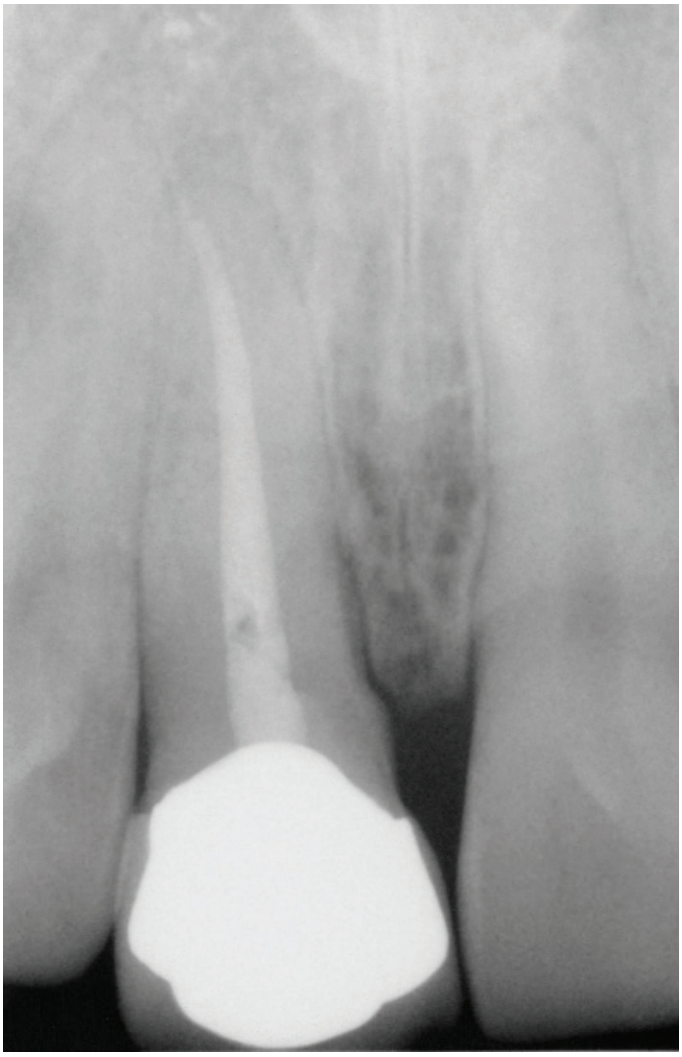

Figure 1b: Initial periapical radiograph demonstrating root proximity of #7 and #8, preventing an immediate implant placement approach.

Extraction

After diagnostic models were obtained, the maxillary right central incisor was extracted using an atraumatic extraction kit (Easy X-Trac System, A-Titan Instruments; Hamburg, NY), leaving the osseous buccal plate and associated periodontium intact **(Fig 2)**. Socket preservation of the site was performed using a demineralized freeze-dried bone allograft (Puros cortical particulate allograft #8271R, Zimmer Dental; Carlsbad, CA) and a collagen plug (CollaPlug, Zimmer Dental) stabilized with isobutyl cyanoacrylate (Iso-Dent, Union Medical Products; Hong Kong, China [PRC]) **(Fig 3)**. An interim Essix appliance was provided to the patient during the healing phase.

Fabrication

Ten weeks post-extraction, a surgical template based on the diagnostic wax-up was utilized to aid the surgeon in placement of a 4.5 x 13.0-mm threaded dental implant (Osseospeed TX, Dentsply Implants; Waltham, MA). The restorative platform of the implant was placed 3 mm apical to the planned gingival zenith to enable proper emergence profile development in the subsequent interim and definitive restorations **(Fig 4)**.

After 12 weeks of healing, an implant-level interim restoration was fabricated using a polyether ether ketone (PEEK) plastic interim abutment (TempDesign 4.5/5.0, Dentsply Implants) and bis-acryl material (Protemp Plus, 3M ESPE; St. Paul, MN) in a direct-fabrication protocol **(Fig 5)**. After the coronal form, facial texture, occlusion, and emergence profile were finalized, an intraoral direct custom-staining protocol was performed.

Characterization

The facial surface of the interim restoration was lightly roughened to enhance subsequent bonding steps with a coarse abrasive disc (Sof-Lex, 3M ESPE) at stall speed, thereby maintaining secondary facial anatomy **(Fig 6a)**. Next, 35% phosphoric acid (Ultra-Etch, Ultradent; South Jordan, UT) was applied for 15 seconds to the facial surface, followed by rinsing and thorough drying, result-

> "Acrylic stains suffer from lack of standardization, based upon the powder-to-liquid ratios, as well as an inability to have temporal control over stain localization due to autopolymerization properties."

Figure 2: Atraumatic extraction of the maxillary right central incisor after confirmation of a vertical root fracture and hopeless prognosis.

Figure 3: Immediate postoperative view of site preservation, demonstrating a minimally invasive extraction approach.

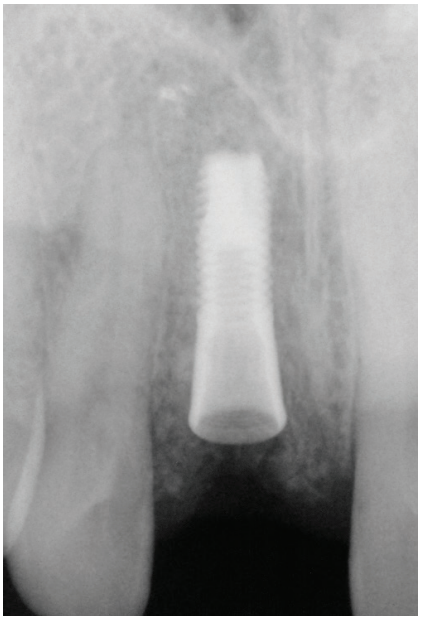

Figure 4: Immediate postoperative radiograph of implant placement.

Figure 5: Screw-retained, directly fabricated maxillary right central incisor interim implant restoration. The restoration lacked a natural appearance due to a monochromatic restoration.

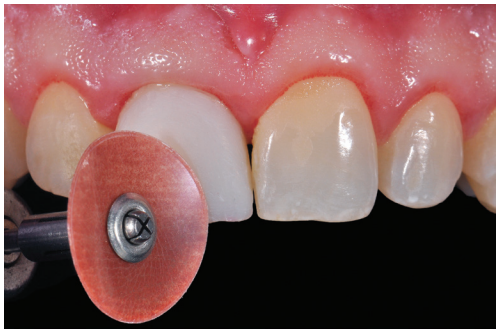

Figure 6a: A coarse disc is used at stall speed to roughen the facial aspect of the bis-acryl interim restoration.

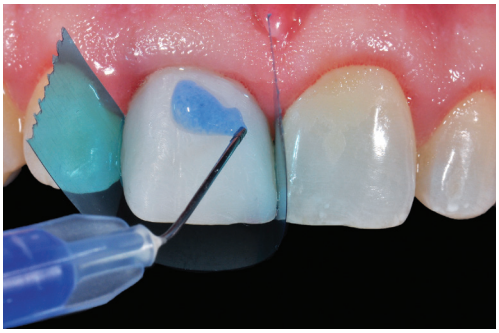

Figure 6b: Thirty-five percent phosphoric acid is applied to the facial surface of the bis-acryl interim restoration to facilitate subsequent bonding of the "resin backdrop" and stain modifiers.

Figure 6c: Thorough rinsing of the phosphoric acid and drying of the interim restoration.

Figure 6d: An unfilled "resin backdrop" is applied to the facial surface and left uncured during subsequent application of stain modifiers.

Figure 6e: Yellow resin modifier is applied to the cervical third of the clinical crown, mimicking the higher chroma in the contralateral central incisor.

Figure 6f: Grey resin modifier is applied to the body of the clinical crown to reduce the value of the interim restoration.

Figure 6g: An explorer tine is used to apply white resin modifier to mimic hypocalcifications present on the contralateral incisor.

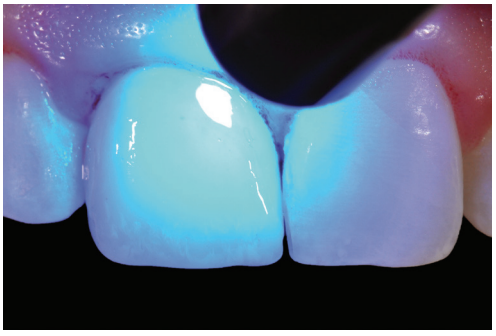

Figure 6h: Only after all resin modifiers have been added to the "resin backdrop" is the resin complex cured with a curing light.

ing in a surface receptive to bonding **(Figs 6b & 6c)**. The application of an unfilled "resin backdrop" (Permaseal, Ultradent) was applied to the entire facial surface and left uncured **(Fig 6d)**.

Yellow resin modifier (Kerr Kolor Plus) was added to the cervical third of the interim with a filament brush (Blick Scholastic Wonder White Script, Blick Art Materials; Galesburg, IL) to mimic the higher chroma in this region of the contralateral tooth **(Fig 6e)**. Grey resin modifier was added to the middle third of the interim to decrease the value in this region with an identical filament brush **(Fig 6f)**. White resin modifier (Kerr Kolor Plus) was added to the incisal third using a dental explorer tine (23 Shepherd's Hook Explorer, Hu Friedy; Chicago, IL) to mimic the hypocalcifications present in this region of the contralateral natural incisor **(Fig 6g)**. The resin modifiers were simultaneously cured using a dental curing light (Demi Plus LED, Kerr) **(Fig 6h)**. A low-viscosity, clear resin polish (Biscover LV, Bisco; Schaumburg, IL) that does not possess an oxygen-inhibited layer was subsequently applied to the entire facial aspect of the interim restoration as a surface sealant and final glaze.

Bleaching and Placement

Six weeks after provisionalization **(Fig 7)**, the patient expressed the desire to externally bleach his dentition prior to placement of a composite restoration on the mesio-lingual-facial aspect of the maxillary left central incisor and fabrication of the definitive implant-supported restoration. External bleaching was completed using a custom tray and 20% carbamide peroxide (Opalescence, Ultradent) **(Fig 8)**. To provide the patient with improved symmetry and dominance of the maxillary central incisors, the maxillary anterior dentition was isolated under rubber dam three weeks after external bleaching was completed. The maxillary left central incisor was etched with 35% phosphoric acid solution (Ultra-Etch) for 30 seconds, rinsed, and dried thoroughly. A resin adhesive (Optibond FL, Kerr) was applied to the mesio-lingual-facial

Figure 7: Six-week postoperative view of the interim restoration integrated with surrounding natural dentition (note coronal width asymmetry to be corrected between central incisors).

Figure 8: Dentition after completion of external bleaching. If desired, the original interim characterization can be abrasively removed and re-applied to match the bleached dentition.

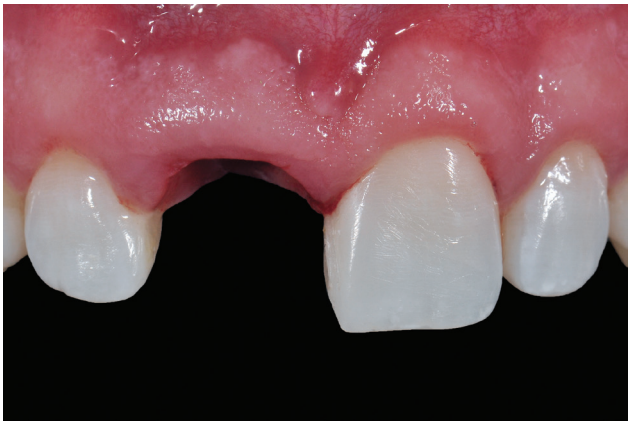

Figure 9a: The peri-implant tissues viewed from the facial aspect. The maxillary left central incisor was restored with composite to harmonize the widths of the central incisors.

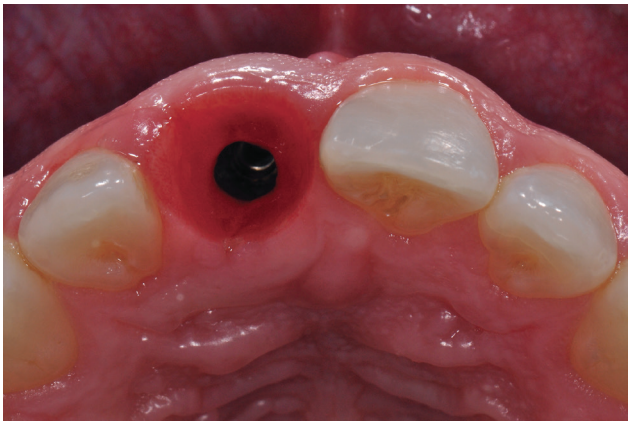

Figure 9b: The developed peri-implant sulcus architecture viewed from the occlusal aspect after provisionalization.

aspect of the maxillary left central incisor and light-cured (Demi Plus LED) for 30 seconds. A nanohybrid composite resin (Filtek Supreme Ultra, 3M ESPE) was stratified using shades B1B and B1E to optimally match the adjacent bleached natural dentition. The mesio-distal dimension of the central incisors was verified with a digital caliper (Mitutoyo Digimatic, Mitutoyo America; Aurora, IL) to ensure adequate symmetry.

After restoration of the maxillary left central incisor to establish symmetry between the central incisors, the peri-implant soft-tissue contours were verified **(Figs 9a & 9b)**. An open-tray final impression was obtained utilizing a custom impression coping technique[20] **(Figs 10a & 10b)**, thus facilitating fabrication of a master cast that accurately duplicated the peri-implant sulcus architecture seen clinically. A computer-aided design/computer-aided manufacturing (CAD/CAM) zirconia-shaded abutment (Atlantis, Dentsply Implants) was designed and fabricated to allow for optimum peri-implant soft-tissue support and margin placement **(Fig 11a)**. A lithium disilicate (IPS e.max, Ivoclar Vivadent; Amherst, NY) abutment-supported restoration was fabricated with a facial cutback and layering technique to mimic the adjacent incisor's characterization **(Fig 11b)**. One month post-cementation, to harmonize the gingival zenith position of the maxillary right central incisor relative to the contralateral central incisor, an 810-nm diode laser (Odyssey Navigator, Ivoclar Vivadent) at 0.8 W pulse mode was used to recontour the gingival zenith **(Fig 11c)**. A more symmetric gingival zenith position was seen one month postoperative **(Fig 11d)**, and a natural emergence profile was visible clinically **(Fig 12)** and radiographically **(Fig 13)**.

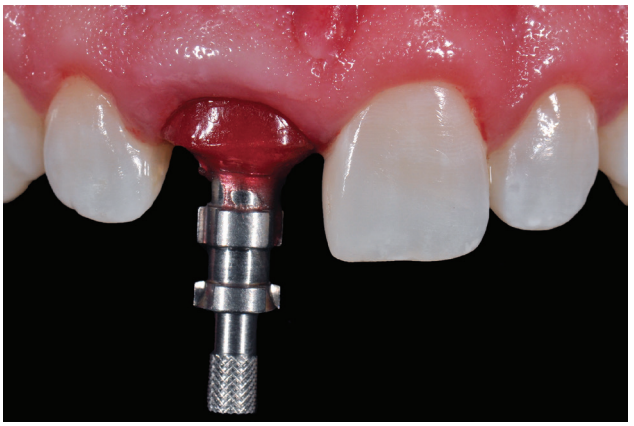

Figure 10a: A custom impression coping was used to capture the mature peri-implant sulcus.

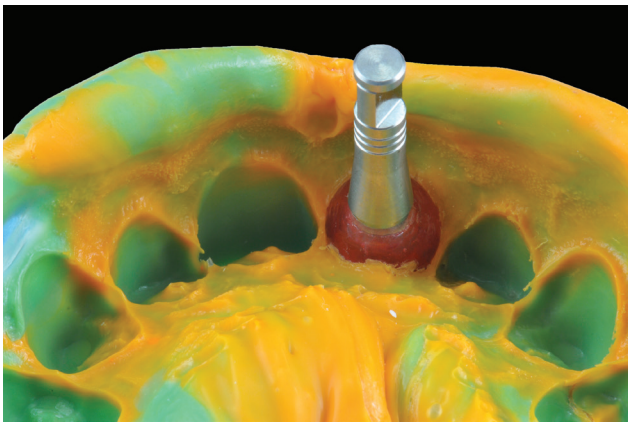

Figure 10b: The master impression with the implant analog displacing the resin modifier apical to the gingival zenith.

Figure 11a: The custom CAD/CAM shaded-zirconia abutment, allowing for optimization of margin placement, gingival support, and ideal reduction for a subsequent all-ceramic restoration.

Figure 11b: The final restoration one month postoperative.

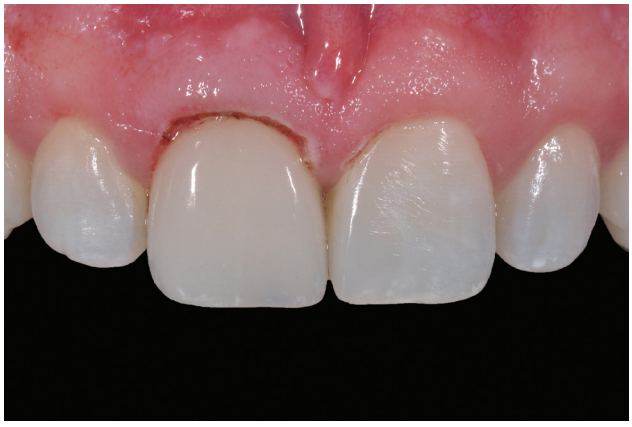

Figure 11c: An 810-nm diode laser was used to optimize the gingival zenith position of site #8 relative to the contralateral natural central incisor.

Figure 11d: Definitive clinical outcome, one month after gingival recontouring.

Summary

Light-curable resin color modifiers offer the clinician a time-efficient and practical means by which to characterize interim restorations to mimic adjacent natural teeth. When indicated, characterization requirements of interim restorations are often subtle **(Fig 14)**, but in some cases may be more overt **(Fig 15)** and depend upon the clinical scenario and the patient's desire to maintain natural characteristics in their prosthetic restoration.

To allow for the most predictable results, when applying the initial "resin backdrop," it is critical that this resin increment not be cured until all subsequent resin color modifiers have been added. The unfilled "resin backdrop" enables the clinician to disperse subsequent stain modifiers in a more ideal fashion with various instrumentation. If this resin layer is cured prior to the addition of the subsequent resin modifiers, the modifiers tend to bead on the surface of the cured resin, rather than disperse into the resin matrix. Allowing for dispersion of the resin color modifiers into the uncured "resin backdrop" matrix pro-

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Figure 12: Lateral view of the implant-supported restoration, displaying a natural emergence from the soft tissues.

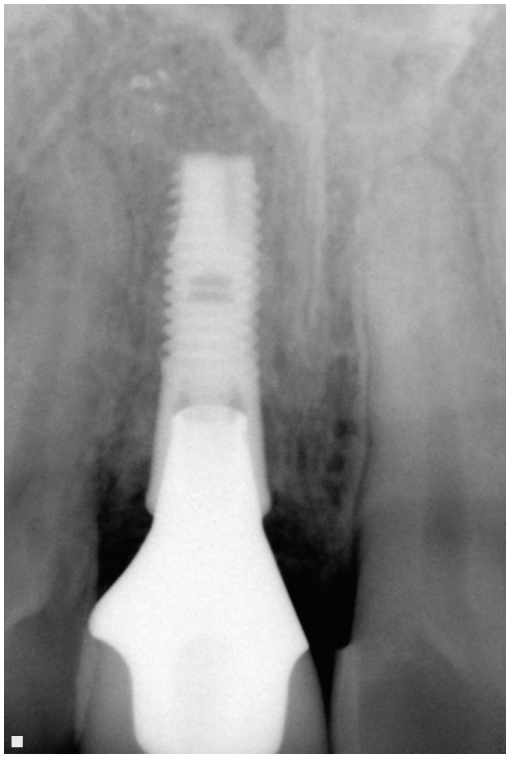

Figure 13: Final periapical radiograph of the completed implant-supported restoration.

vides a more natural and subtle appearance to the characterization.

The authors have found that direct characterization of interim restorations serves three vital purposes for the restorative team.

First, it enables the patient to have direct, chairside input into the character of the final restoration at the time of provisionalization. This enables the patient to try out the characterized restoration, and, should preferences change prior to fabrication of the definitive restoration (e.g., external bleaching, macro/micro-abrasion), it is straightforward and time-efficient for the clinician to alter the character of the interim chairside. Such alterations are not as feasible for the clinician while chairside with indirectly fabricated or stratified interim restorations, where character attributes may be internally embedded in the restoration. Upon finalizing the characterization of the interim restoration, the patient can approve the desired esthetic appearance of the final restoration during the interim treatment stage.

Second, the finalized character of the interim can serve as a blueprint for the ceramist to duplicate in the final prosthesis. This can be achieved via the use of calibrated digital photography workflows, direct chairside customization by the ceramist (if available), or a secondary duplicate "blank" that has been identically custom-characterized and sent to the laboratory by the clinician as a reference.

Third, customization of the interim restoration helps the patient to realize that the clinician is dedicated to achieving an ideal esthetic result and is concerned for the patient's well-being.

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Figure 14: Characterized interim implant-supported restorations for both maxillary lateral incisors; the patient desired to maintain his current dental "character."

Figure 15: A patient with profound maxillary anterior characterization. The interim implant-supported restoration at site #7 integrated well with the surrounding natural dentition.

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(CE) Exercise No. jCD 11

Implant Restorative (Implants)

AGD: Subject Code: 695

The 10 multiple-choice questions for this Continuing Education (CE) self-instruction exam are based on the article, "*Direct Extrinsic Characterization: Maximizing Esthetics of Fixed Interim Restorations*," by Dr. Chris Barwacz and Dr. Maria Marcela Hernandez. This article appears on pages 122-131.

The examination is free of charge and available to AACD members only. AACD members must log onto www.aacd.com to take the exam. **Note: Only Questions 1 through 5 appear in the printed and digital versions of the *jCD*; they are for readers' information only.** The complete, official self-instruction exam is available online only—completed exams submitted any other way will not be accepted or processed. A current web browser is necessary to complete the exam; no special software is needed. The AACD is a recognized credit provider for the Academy of General Dentistry, American Dental Association, and National Association of Dental Laboratories. For any questions regarding this self-instruction exam, call the AACD at 800.543.9220 or 608.222.8583.

1. Customized interim restorations

a) provide little information to assist patient/clinician communication.
b) aid in directing a ceramist in the fabrication of the final restorations.
c) should be functional and not be based on the patient's expectations.
d) are best done freehand without the use of a laboratory mock-up.

2. Matching treatment outcomes to patient expectations

a) has no relationship to patient satisfaction or behavioral markers.
b) has a direct relationship with behavioral markers but provides little in regard to patient satisfaction.
c) has a direct relationship to both patient satisfaction and behavioral markers.
d) has a direct relationship to patient satisfaction but provides little in explaining behavioral markers.

3. According to the authors, in the fabrication of direct interim restorations,

a) achieving proper emergence profiles is a challenge due to the lack of available techniques.
b) it is a challenge to replicate primary and secondary texture due to a lack of available techniques.
c) reproduction of nuanced characteristics can be a significant challenge.
d) idiosyncrasies inherent in the surrounding dentition need not be replicated.

4. Indirect interim fabrication

a) is discouraged when multiple restorations are required.
b) offers the clinician more efficient use of chair time.
c) has no advantage concerning physical properties of the material.
d) is most often readily employed for single or short-span restorations.

5. Characterization

a) of indirect interim restorations can be achieved via additive or subtractive methods.
b) of direct/indirect interim restorations is best achieved by surface application of tints and opaquers.
c) of interim restorations is generally not desired by demanding patients.
d) is typically not a requirement when utilizing a direct fabrication technique.

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