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Journal of Cosmetic Dentistry

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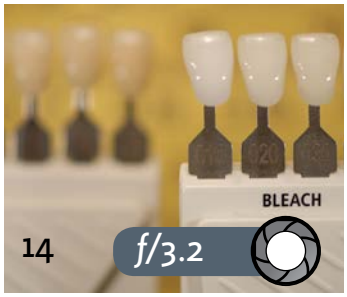

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The Wonder Years...

The biennial International Dental Show (IDS) took place in March, in Cologne, Germany. There were more than 220 exhibitor booths dedicated to CAD/CAM dentistry and digital scanning software and hardware.

My first experience with digital dental photography was in 1997, with a modified Kodak DC40 digital camera that stored 48 pictures in its 4MB of internal memory. It did not have an LCD for picture display. Interchangeable lenses attached to football goalpost-shaped framing forks were used for dental macro photography of a smile or a close-up image of teeth. It was awkward and crude by today's standards but it was cutting-edge technology at the time.

As an avid fan of film photography with a traditional single-lens reflex (SLR) camera, I jumped on the bandwagon with the naysayers. Their mantra was, "Digital photography will never replace film."

At that time, Eastman Kodak was one of the most successful photography companies in the world. By the late 1970s it enjoyed 85% of camera sales and 90% of film sales in the United States. Most dentists captured clinical photos in Kodachrome or Ektachrome slide film. In terms of 35mm SLR cameras, Nikon, Canon, and Pentax were at the top.

However, in digital photography today, Nikon and Canon are jousting for market domination with other competitors such as Sony and Sigma (in addition to Pentax, Olympus, and Leica).

What happened to Kodak in all this? After all, they brought one of the first digital cameras, the DC40, to market in 1995.

Although Kodak led sales of traditional film cameras in Europe and America in 2004, it was not able to follow through with digital success, filing for Chapter 11 bankruptcy protection in 2012. Despite holding onto patents estimated at $2 billion in value, the company was not able to capitalize on the digital photography field it helped to create.

My point is that we must embrace technological advances. Change makes most of us uncomfortable; we often are fearful that our choices may be wrong and costly, so we "default" to what we know best. That is human nature. However, digital photography today is better than film.

Change makes most of us uncomfortable; we often are fearful that our choices may be wrong and costly, so we "default" to what we know best. That is human nature. However, digital photography today is better than film.

What will be in store for the world when the IDS returns to Cologne in 2015? I can't wait to see!

Edward Lowe, DMD, AAACD
Editor-in-Chief

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How the Ring Flash Changed Dental Photography

Matt Glassgold

Mr. Glassgold is the president of Lester A. Dine, Inc.

Disclosure: The author did not report any disclosures.

Up Front provides a forum for influential leaders to share their opinions. In this issue, we welcome Matt Glassgold, who discusses Lester Dine and the invention of the ring flash. The views expressed in Up Front reflect the opinions of the author. They do not imply an opinion on the part of jCD or the AACD.

From this creation, the world of dental photography grew and in a short time revolutionized the way dentists communicate with patients.

While working at a camera shop in New York City in 1952, Lester Dine was approached by a dentist with the question: "How do I get my camera to light inside my patient's mouth?"

The flash the dentist was holding on top of his camera could not pinpoint light inside the mouth of his subject and every other method the dentist experimented with also proved fruitless. From that conversation, a little tinkering and a lot of ingenuity helped Lester Dine create the ring flash, a circular flash attached to the end of a camera's lens. By combining the ring flash with a lens capable of accurately capturing a close-up/macro subject, the first camera system designed specifically for intraoral photography was born. From this creation, the world of dental photography grew and in a short time revolutionized the way dentists communicate with patients.

The creation of the ring flash put the patient in the dentist's shoes and allowed them to see what the dentist could see in the most relatable form possible—an actual photograph of the inside of their mouth.

Over time, changes were made to simplify the use of the ring flash. Cameras evolved, most notably with a feature called "through the lens" (TTL) flash metering. The TTL concept allowed the camera to gauge the light around the subject through its lens and output light accordingly. Dentists no longer had to adjust flash levels using a power box in an attempt to take consistent photographs or take a series of photos bracketing different flash outputs. The now-evolved camera could do the majority of the work, putting out more or less light depending upon the level of ambient light already around the subject. The "point-and-shoot" nature of TTL flash metering made dental photography far less subjective and enabled virtually any dental office staff member to become the "practice photographer," as the camera could basically take the same photograph regardless of the user.

With the popularity of digital photography exploding in the mid 1990s, dental photography and the ring flash took another great leap. Today's ring flashes attach to a wide variety of digital camera bodies. The digital cameras allow users to review their images on the back of the camera and even send pictures to computers, tablets, and smart phones wirelessly, giving patients an almost instant high resolution and undistorted view of the inside of their mouth.

From its humble beginnings at the hands of an inquisitive dentist and resourceful inventor, the ring flash has been become an essential tool for every dental office, literally illuminating the world of dentistry.

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The "Sight" of Music

> “Sight and sound are synergistic, complementing each other for an enhanced emotional and pleasurable synesthetic experience.”

These surreal images with a dental theme, which I call “The 'Sight' of Music,” were created to visualize the music we hear with our ears and imagine with our mind’s eye. Sight and sound are synergistic, complementing each other for an enhanced emotional and pleasurable synesthetic experience. All visual media—including film, video, and television—rely on this sensual combination for their universal appeal.

The photographic setup for creating these images was relatively simple, but required perseverance to achieve the desired results. As the process was messy and produced paint splashes, it is recommended that anyone seeking to reproduce this effect wear appropriate protective clothing and that the camera, lens, and flashes be covered with cellophane.

A rubber dam sheet was stretched across a speaker cone and secured with screws; bull clips also can be used. A suspended wire held a sectioned tooth over the speaker cone and rubber dam assembly. The speaker cone was connected to an audio amplifier, and the selected music was played. The photographic equipment comprised a Leica S2 digital camera (Solms, Germany) with a Leica Apo-Macro Summarit-S 1:2.5/120 mm lens and two Metz Mecablitz 54 Mz-4i digital flashes (Zirndorf, Germany) placed bi-lateral to the sectioned tooth. The camera was set at aperture f/8, and the shutter speed was one second.

Two people were needed to take the photographs. The first person released the camera shutter, while the second person simultaneously dropped liquid paint of various colors, using a pipette to drop the paint onto the rubber dam sheet while the music was playing.

Depending upon the music genre, intensities of different amplitude can be created that vibrate the rubber sheet, which in turn causes the paint to “bounce” upward to create unique effusions. This is where the process becomes tedious, as many shots are required to capture the precise moment that coincides with the paint striking—and bouncing off—the rubber dam sheet. However, a little time, patience, and experimentation can yield magical images!

To experience the full effect of this image, it is recommended that readers listen to the corresponding music while viewing the image: “Won’t Get Fooled Again”—The Who, from the album *Who’s Next*. The corresponding music for the cover image is “Riders on the Storm”—The Doors, from the album *LA Woman*.

To read Dr. Ahmad’s clinical essay, please turn to page 42.

An Expression of Your Vision

High-Quality Photography

Steven H. Goldstein, DDS

Dr. Goldstein will be speaking at the 29th Annual AACD Scientific Session in Seattle, Washington, on April 26, 2013. The title of his lecture is "Advanced Digital Photography and Digital Asset Management." In this article, Dr. Goldstein gives an overview of the details he will discuss at his lecture.

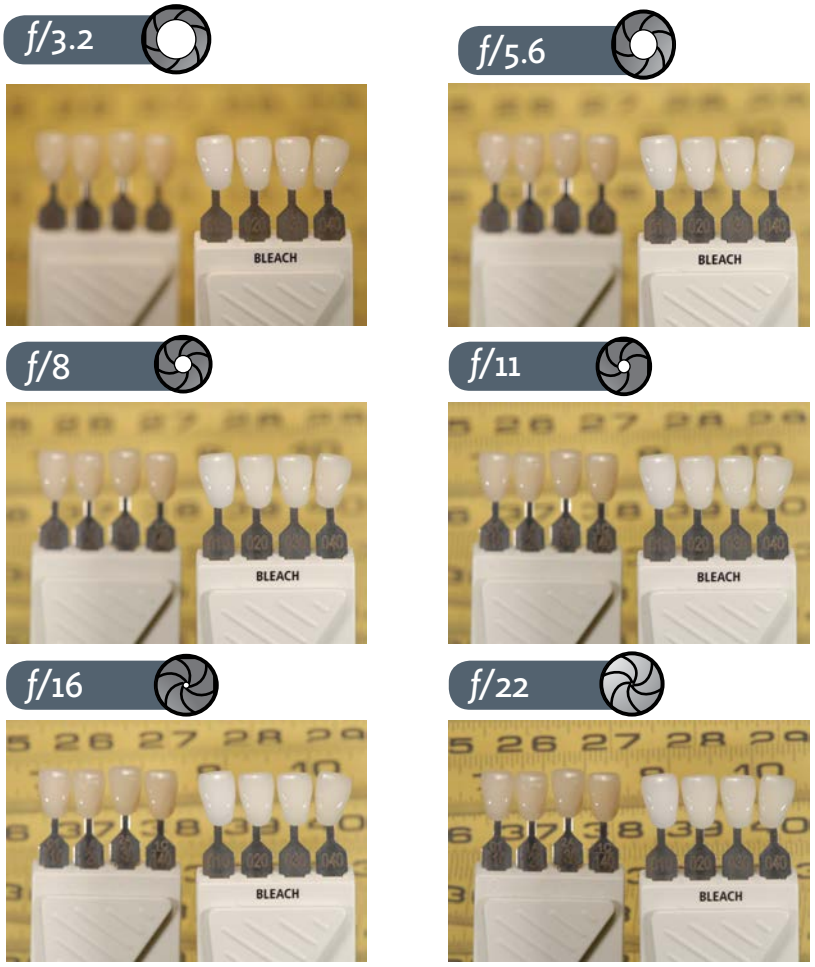
High-quality images are those that clearly depict the subject, are free from distracting backgrounds, are properly exposed and color-balanced, and are in focus.

Introduction

Digital photography is common in many of today's dental practices, and high-quality dental images are paramount for laboratory communication and marketing dentistry. The purpose of this article is to define what a high-quality dental image is, and to give an overview of what these images are used for. During my presentation at the AACD meeting I will show all the steps involved in making these images and review in detail the equipment, camera settings, techniques, and post-production workflow using Adobe Photoshop Lightroom (San Jose, CA).

High-Quality Dental Images

The author believes that high-quality images are those that clearly depict the subject, are free from distracting backgrounds, are properly exposed and color-balanced, and are in focus. Unfortunately, many dental images do not meet these criteria. High-quality images are important, as they are an expression of your vision and are needed to represent the high quality of your dentistry.



These six f-stop images show how a higher f-stop number gives a greater depth of field.

Technical Aspects of Photography

Achieving high-quality images requires a full understanding of the camera settings (which, of course, will vary for each particular type of shot). These include the following parameters:

- white balance (WB)
- file format (RAW versus JPEG)
- color mode
- ISO
- aperture
- shutter speed.

These images show how the white balance setting affects the overall color of the image. It is critical to match the white balance setting on the camera with the appropriate light source.

Patient Education

Dental images can be used to show patients various treatment options and results; this also showcases our laboratory's work. A high-quality image is powerful and often results in motivating a patient to start treatment immediately. The selection of dental images to show patients is critical and should be focused around a theme (e.g., implant dentistry, restorative dentistry). An easy, portable way to show patients images is with an iPad. It is sharp, and simple to add or remove images.

When shooting intraoral images, this author's camera settings are:

- WB: flash
- file format: RAW
- color mode: Adobe RGB
- ISO: 100 (the lowest setting for the particular camera)
- aperture: f/22
- shutter speed: 1/160th.

These settings consistently provide images that are color-balanced and sharp with good depth of field.

This is a typical intraoral image. It is sharp, color-balanced, and has an adequate depth of field.

Patient Treatment Decisions

It is often difficult to explain technical dental procedures to patients. The saying, "a picture is worth a thousand words" is true when it comes to showing patients various treatment options. For example, trying to describe to a patient what a "hybrid denture" is without images or models is almost impossible. Using photography showing a beautiful natural smile allows patients to understand the proposed treatment and lets them decide if they want to proceed.

The case discussed here clearly demonstrates how attractive a smile can be with a full implant-supported hybrid restoration. The photographs will help to alleviate a patient's initial esthetic concerns.

Patients often are hesitant to finalize treatment, especially when esthetics are concerned. Candid images allow patients to view themselves realistically. To the right is a candid image of a patient laughing with full upper and lower dentures inserted at the trial set-up appointment. The image allows the patient to evaluate the esthetics of the teeth with respect to her face during a normal conversation. The image was also e-mailed to the patient, allowing her to share it with friends and family members.

Showing a patient a beautiful finished implant-supported hybrid case (a) is much more effective than having them view the technical laboratory image (b).

This candid image of a full upper and lower denture trial setup allows the patient to see what her teeth will look like during a conversation.

A good image of a well-done mock-up is powerful and motivating to patients who are undecided about cosmetic dentistry, allowing them to see exactly what is possible.

This small custom lighting setup produces stunning images that rival images made with larger and more expensive gear.

Mock-Ups and Provisionals

Mock-ups and provisionals are the key to successful dentistry. A mock-up (based on the diagnostic wax-up) gives the doctor and patient a preview of the final case. This can be photographed and the images given to the patient (via hard copy or e-mail). This is a very powerful tool that allows a patient to make an important emotional and financial decision based upon accurate information. It will also help the clinician and laboratory produce a predictable and beautiful final product.

Photographing the six-unit mock-up in this case helped this patient visualize what her final case would look like. Increasing the length of maxillary incisors is often difficult for a patient to initially accept, since they are used to seeing themselves with short teeth. The images were then e-mailed to the patient's home, giving her time to evaluate the esthetics before committing to treatment. The mock-up is easily modified and photographed.

Portrait Photography

Beautiful portraits are another way to showcase your dental work to patients. Many patients are more likely to be influenced by a nice portrait with a beautiful smile versus viewing a close-up image of teeth. Understanding how light works is critical in making a beautiful portrait: hard and soft qualities, as well as the color and position of lights, make or break an image. Learning to use minimal photographic equipment in an efficient workflow will allow the clinician to easily take gorgeous portraits.

An understanding of the principles of light will help clinicians to take professional quality portraits with a minimal amount of equipment. The author does not have a lot of office space for a full professional photography studio, nor does he want to set up large lights on tripods every time a professional portrait is needed.

Using small wireless strobes (Nikon SB-800s [Melville, NY] and the IR controller SU-800) allows the author to create a makeshift studio anywhere in the office in minutes. The dramatic portrait on the left was made by placing the patient far from the background, removing the light source from the camera, choosing an f/stop that forced the background to turn black, and using the existing macro lens (Telephoto AF Micro-Nikkor 105mm f/2.8G ED-IF AF-S VR) as a telephoto. This image is straight from the camera with no modifications whatsoever (1/160 sec at f/22). (Please note that *written permission* from the patient is required in order to show their full face publicly.)

Laboratory Communication

Digital photography is a wonderful communication tool between the dentist and the laboratory. Being able to show the laboratory technician clinical images helps them produce a better product. This includes, but is not limited to, pre- and postoperative images, shade selections, in-progress casework, and impressions.

Here, the technician sent images of a veneer case that was completed. The mesial-incisal edge of the right maxillary lateral incisor needed to be lengthened. The technician added porcelain and the case was inserted uneventfully. Having "multiple sets of eyes" looking at a case increases its quality and the likelihood of being accepted.

Dental Education

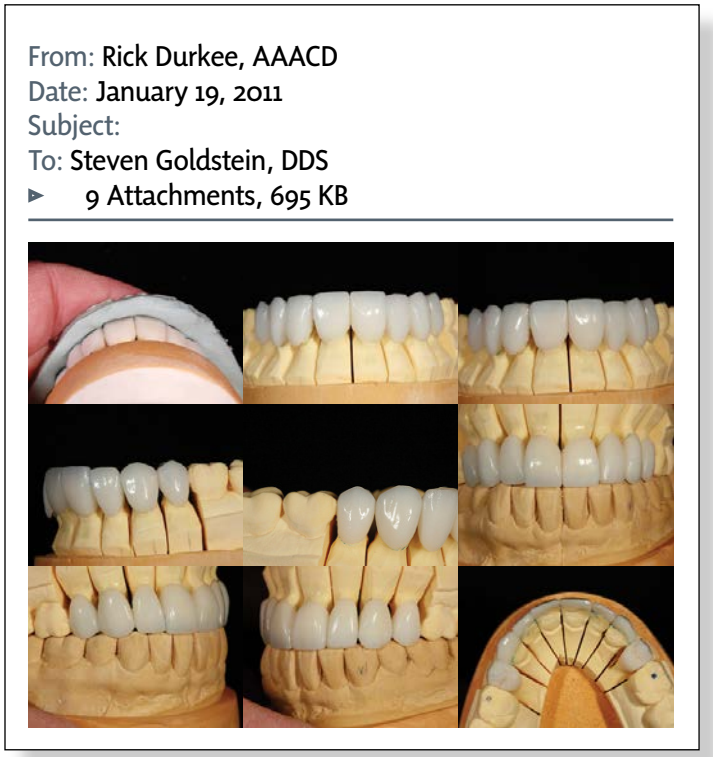
Dental images viewed from a projector controlled by a laptop computer are commonly used to present casework at meetings or educational institutions. Describing various techniques, materials, or procedures is simple when the images are clearly depicted. High-quality images help keep the audience engaged and interested in the subject being presented.

Post-Production

Digital asset management (DAM) refers to the organization and workflow of digital images (called "assets"). DAM involves importing images into a computer, organizing them so they are easily found, and outputting selected images to various media in order to share them with a particular audience.

Clinicians must have an efficient DAM system in place to download, organize, and share digital assets easily and effectively. Software bundled with many digital cameras is limited in features offered, and most do not allow for precise image organization and editing. Most are considered "browsers" that allow the user to browse the captured images and have limited output potential as well.

The author's software of choice is Adobe Photoshop Lightroom. Lightroom works on both Apple and PC platforms, is relatively inexpensive, and has a moderate learning curve.



E-mailed images from and to the dental laboratory make the final case results more predictable for the doctor, laboratory technician, and patient.

Images detailing specific dental techniques, instrumentation, and procedures.

"Grid" view of dental images in Adobe Photoshop Lightroom. Images appear as "slides" and are easily organized and shared.

Sending an e-mail image today is simple with most professional software packages. The software will create JPEG copies from the original RAW images (leaving the original intact) with an ideal file size for e-mail. This process takes minutes and is easily implemented into a dentist's workflow.

A key point to understand about Lightroom is that it is cataloging software. It does not physically import (move) images into the software. Images are downloaded from the compact flash card onto the user's hard drive to a predetermined location (e.g., a folder named Dental Images). Lightroom recognizes where the images are and builds a data catalog. The software never moves or alters the original images. The user can store them physically anywhere (internal or external hard drive). However, if the images are moved from their original location, Lightroom will not be able to find them until the user tells Lightroom the new location. This is a wonderful feature since the images are protected and preserved in their original state.

This software allows the doctor to do the following:

- find images easily
- browse through unlimited images, selecting desired images for sharing
- edit images non-destructively
- output images easily to a multitude of devices and books
- automate backups effortlessly.

Summary

Digital dental photography is no longer merely an "option" for the progressive dental practitioner. Creating high-quality images is paramount for multiple uses in dentistry today. All of the above techniques and equipment will be reviewed in detail during the author's presentation at the AACD meeting in Seattle.

Acknowledgment

The author thanks Rick P. Durkee, CDT, for the e-mailed image on the previous page.

Dr. Goldstein practices in Scottsdale, Arizona.

Disclosure: The author had no relevant affiliations to disclose.

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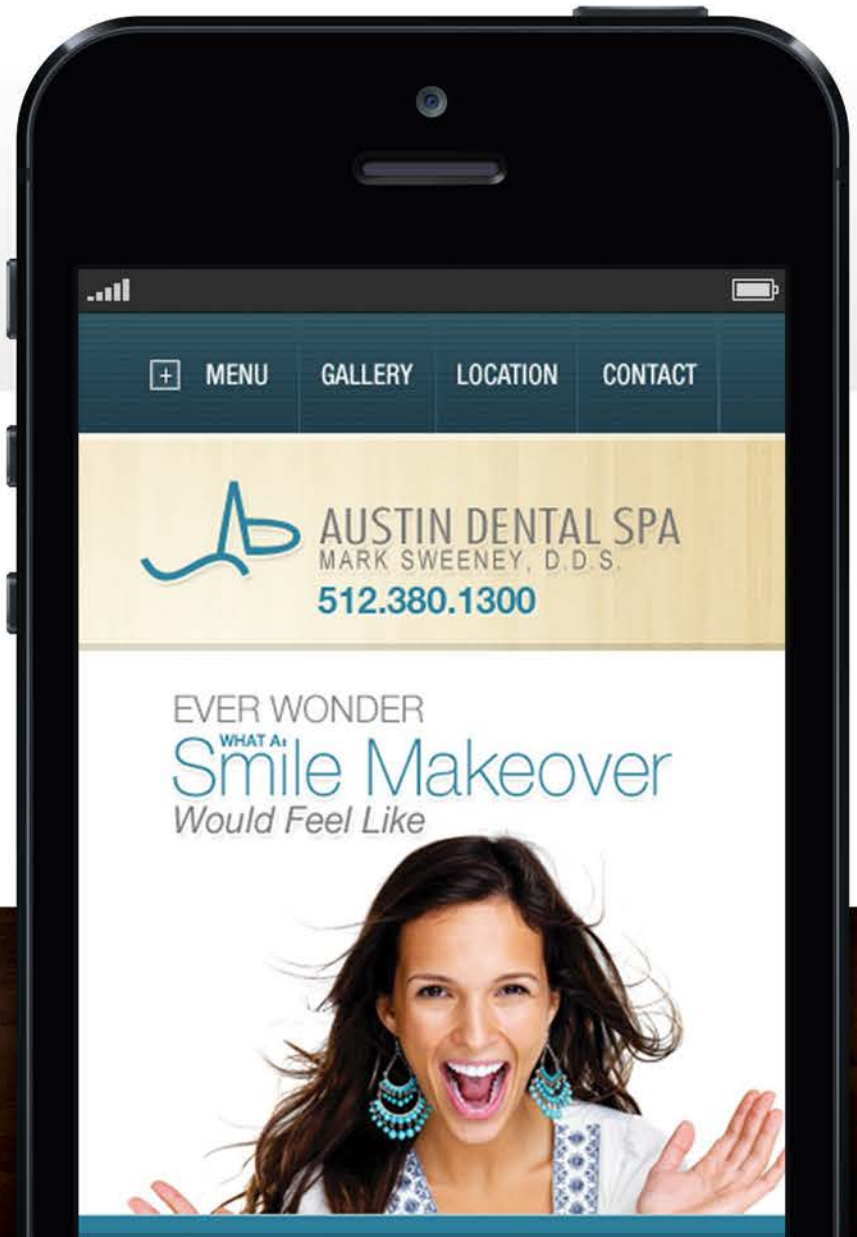

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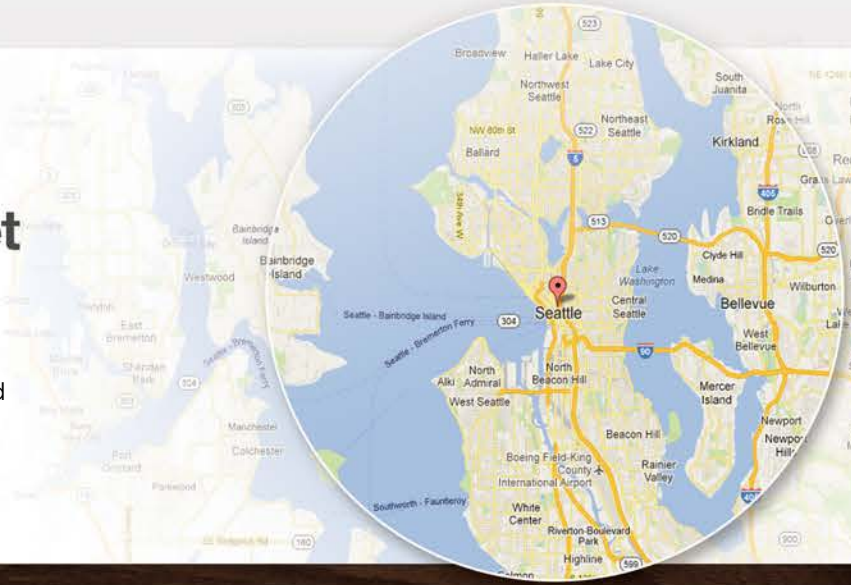

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Figures 1a & 1b: Full-face smile before and after, 1:10. The patient was very happy to smile confidently again.

Key Words: Accreditation, Class IV composites, composite bonding, minimally invasive, esthetic technique

Introduction

Dental trauma to the anterior maxillary teeth is common in children. Along with dramatic improvements in bonding technology, and resin composites' physicochemical properties and esthetic qualities, modern composite resin restorations can conservatively replace missing tooth structure. Bioesthetics is especially important when treating young patients, giving priority to additive, minimally or micro-invasive procedures to preserve tooth biology and biomechanics.[1]

Excellent and minimally invasive restorations can be created with relatively simple application and layering techniques using artificial dentin and enamel masses, which are completed with effect materials.

> **"Bioesthetics is especially important when treating young patients, giving priority to additive, minimally or micro-invasive procedures to preserve tooth biology and biomechanics."**

Figure 2: Portraiture setup for a dental office.

Clinical Case

History and Complaint

The patient, a 10-year-old boy, came to the office with his mother to restore the fractured incisal two-thirds of his maxillary right central incisor. The etiology of the tooth fracture was a fall from a bicycle two days earlier. The fractured fragment of the patient's tooth had been lost. The patient's mother sought high-level, conservative, restorative treatment to restore the fractured tooth to its natural appearance. The patient had an unremarkable medical history and a dental history that included routine fillings and sealants.

AACD Photographs

To perform a high-quality restoration requires more than consultation time, so the patient was invited to have photographs taken for review and study of the AACD Accreditation views.[2] The patient's portrait **(Figs 1a & 1b)** was taken in a portraiture setup for a dental office **(Fig 2)**[3]: two symmetrical strobes with a softbox and a light shaper as main lights, hair light strobe with a reflector, velvet curtain background, Nikon D300 camera (Melville, NY) and Nikkor lens 18-70 mm f/3.5-4.5G ED-IF zoom AFS DX. The patient's smile and teeth **(Figs 3-6)** were photographed using the same camera, Nikkor lens 105 mm F2.8G VR micro, Sigma electronic flash macro EM-140 DG (Sigma Photo; Ronkonkoma, NY); and dental photography accessories such as lip retractors, contrasting device, and occlusal mirrors **(Figs 7a & 7b)**.

A second appointment was made several days later to perform final treatment with composite.

Examination

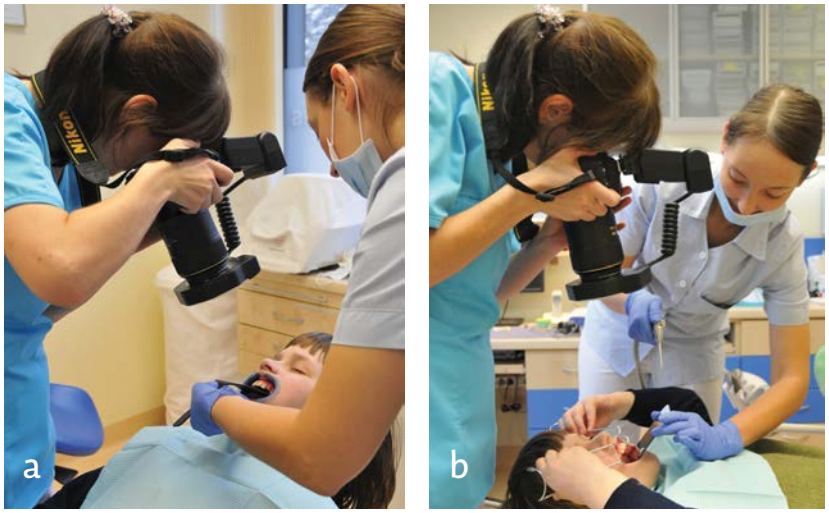
A thorough examination was performed and appropriate radiographs taken. The clinical exam revealed no signs or symptoms of temporomandibular joint or occlusal disorder. Visual and tactile inspection of the soft tissue showed them to be within normal limits and free of pathology. The teeth were evaluated and checked for any possible fractures, pulp exposures, and mobility. There was no radiographic or clinical evidence of pulpal exposure or root fracture and the patient had experienced no spontaneous pain since the accident. Tooth #8 responded to cold, was negative to percussion, and did not exhibit mobility.

Figure 3: Preoperative close-up right lateral view.

Figure 4: Preoperative 1:2 full natural smile view.

Figure 5: Preoperative 1:2 retracted frontal view.

Figure 6: Preoperative 1:2 occlusal view.



Figures 7a & 7b: The teeth were photographed using lip retractors, a contrasting device, and an occlusal mirror.

Treatment Plan

A Class IV composite restoration was the treatment of choice because of the patient's age, and to conserve remaining tooth structure. Class IV composite combining microhybrid and microfill that are completed with effect materials would fulfill the patient and his mother's expectations and meet current biomechanical and esthetic standards.

The following esthetic and restorative issues were discussed with the patient's mother:

- functional issues
- longevity
- possible need for endodontic management and discoloration of the residual tooth structure and root of the traumatized tooth
- recare and maintenance: observation, management, and evaluation.

Treatment

Color and texture mapping were used to guide the layering of composite to achieve a polychromatic result.

A topical anesthetic was applied in the buccal fold apical to #8, and the patient was anesthetized with one carpule of Septanest (Septodont; Lancaster, PA) with adrenaline 1/100,000.

A shade determination was done before the teeth became dehydrated and changed value during treatment. A spectrophotometer (Shadepilot, DeguDent; Hanau, Germany) reading was made on both #8 and #9 to help determine the appropriate shade of the final composite resin. The body shade was A-3 (VITA, Vident; Brea, CA).

The following materials and shades were selected:

- flowable composite G-aenial Flo AO3 (GC America; Alsip, IL), as a cavity liner
- microhybrid composite G-aenial Anterior A03 for artificial dentin (AD), to provide opacity, hue, and chroma
- microhybrid composite G-aenial Anterior A2 for artificial chromatic enamel (ACE), to provide hue, chroma, and value
- Renamel Creative Color Opaquer White (Cosmedent; Chicago, IL), to reproduce whitish, opaque enamel hypoplasia effects
- Renamel Microfill Incisal Medium for artificial achromatic enamel (AAE), to create effects ranging from translucency to milky-whiteness and for polishing ease and longevity when exposed to varying degrees of pH levels (i.e., low pH, high acidity, and brushing)[4]
- Adhesive Prime&Bond NT (Dentsply DeTrey GmbH; Konstanz, Germany).

A color mock-up was completed in the patient's mouth to verify the composite "recipe" that would mimic the colors and texture of the adjacent intact central tooth. During this process, the lingual shelf, the dentin, characteristics of white spots, and chromatic and achromatic enamels were applied to envision a highly esthetic final result. The mock-up allowed for thickness corrections prior to creation of the final restorations.[5,6]

Undetectable integration of composite resin with natural tooth structure requires attention to detail and the use of correct composite materials, as well as the application of a consistent protocol.

Prior to preparation, the teeth were cleaned using fluoride-free toothpaste (Zircate, Dentsply), prophy brushes, and dental floss. Tooth #8 was disinfected with chlorhexidine.

Preparation

Preparation began with a round-end diamond bur (6856-016, Brasseler USA; Savannah, GA) with a deep and long bevel extended 2 mm around the entire facial and lingual margins. This greatly increases the surface area of enamel available for bonding. When giving the preparation its final inspection, using an extra-fine diamond bur (7803, Shofu Dental; San Marcos, CA), any unstable or overhanging enamel structures were removed, as they have a negative effect on the adhesive bond of the restoration. Weak enamel structures left untrimmed at the margins lead to the so-called "prism effect" once composite is applied.[7]

Adhesion

The rubber dam (SigmaDam, Sigma Dental Systems GmbH; Flensburg, Germany) was applied from tooth #3 to #14. The prepared tooth #8 was sandblasted with 50 µ aluminum oxide (MicroEtcher II A, Danville Materials; San Ramon, CA) to clean the preparation and enhance adhesion.

Acid-etching with 38% phosphoric acid (Etch-Rite etching gel, Pulpdent; Watertown, MA) was performed over enamel for 30 seconds and dentin for 15 seconds to remove the smear layer, which forms after dentin preparation, and to open collagen fibers. After rinsing with water for 30 seconds, adequate humidity control is important since the total dehydration of dentin is contraindicated.[8] When using phosphoric acid as an etchant, a wet bonding technique is necessary to keep the collagen meshwork open for resin monomer penetration. Adhesive (Prime&Bond NT) was applied, air-thinned, and light-cured for 20 seconds.

Composite Placement

Flowable composite was injected into the floor of the cavity ensuring there were no bubbles, and polymerized for 20 seconds using a light-emitting diode (LED) curing unit (Bluephase 20i; Ivoclar Vivadent; Amherst, NY). Applying flowable composite as a liner improves contact with the preparation walls, reducing bubbles or gaps between the adhesive layer and the composite resin.[9] Also, the flowable composite liner reduces polymerization shrinkage stress and can act as a sort of "shock absorber."[10]

Then, in three subsequent layers, AD composite (shade A03) of higher chroma than the intended enamel chroma was applied and sculpted to conform to the histological boundaries of the natural dentin and light-cured for 20 seconds each. To maximize curing effectiveness, curing light guides should be maintained in close proximity to the surface of the light-activated restorative material.[11]

This was followed by applying a layer of ACE (shade A2) on the palatal aspect of the tooth. The palatal enamel wall was modeled freehand and light-cured for 20 seconds. Then material of ACE (shade A2) was used over the labial surface of the composite. This layer was smoothed and shaped with an artist's brush (#3, Cosmedent) to provide an even surface and minimize the incorporation of any air pockets. The IPCT carver (Cosmedent) was used to make a random bevel and groove for the subsequent incisal composite, and the layer was light-cured for 10 seconds.

An artist's brush (#1, Cosmedent) was used to apply patches and bands of Creative Color Opaquer White to reproduce the fluorotic enamel structure **(Fig 8)**, as seen on tooth #9. The layer was light-cured for 20 seconds.

A final layer of AAE composite (Incisal Medium) was applied to cover the entire facial aspect. This achromatic enamel has the ability to diffuse the light to some extent, while permitting the colors of the underlying layers to selectively show through.[5] The layer was cured for 20 seconds.

The intact cervical hard tissues of #7 and #8 allowed a transparent strip (KerrHawe; Bioggio, Switzerland) to be wedged in (Luciwedge Soft, KerrHawe), adapted, and correctly shaped. Then a thin layer of AAE composite (Incisal Medium) was applied to the facial and palatal surfaces. To achieve uniform composite transition from the facial to palatal surfaces and contour proximal surfaces in convex form, the matrix was slightly pulled to the palatal, then pressed from both sides (controlling avoidable composite overhangs on the palatal surface), and light-cured for 20 seconds. The final layer wedge, strip, and rubber dam were removed.

Finishing

A composite polishing disc (Sof-Lex extra/coarse, 3M ESPE; St. Paul, MN) and flame-shaped fine and extra-fine diamonds (8859-010, 859EF-010, Brasseler) were used to remove excess material, recontour, and establish outline form. The flame-shaped burs were worked along the axis of the tooth, from mesial to distal side, producing a perikymatous surface structure. The contouring was guided by comparison with the three planes of the contralateral tooth. Excess material on the palatal side was removed using a football-shaped diamond bur (6368-023, Brasseler).

Symmetry of the central incisors was verified using a digital caliper (Dentagauge, Erskine Dental; Marina Del Ray, CA).

Figure 8: Creative Color Opaquer White was used to reproduce the fluorotic enamel structure.

Figure 9: In the "after" 1:1 frontal view, the translucency, halo, and whitish, opaque enamel hypoplasia effects create a lifelike mirroring of the adjacent central incisor.

The proximal surface was polished using a finishing diamond strip (NTI-Kahla GmbH; Kahla, Germany). Facial and palatal surfaces were modeled with ultra-fine diamonds (LT2, 7406, Shofu). Static and dynamic occlusion was optimized using articulating film (TrollFoil, Trollhätteplast AB; Trollhättan, Sweden). All surfaces were polished using polishing points (Enhance, Dentsply) and FlexiDiscs (Cosmedent).

Before the final polishing, the restoration was covered with a layer of "air-block" water-soluble glycerin (Glycerin-gel, Ivoclar Vivadent). Final polymerization was carried out with 20-second cycles on the palatal and facial surfaces to obtain the maximum monomer conversion in the uppermost layer of composite material, normally inhibited by oxygen.[12] A FlexiBuff disc with Enamelize paste (both Cosmedent) was used to obtain the final gloss **(Fig 9)**.

The patient was given home care instructions and scheduled to return three days later for a final check of function and esthetics, and to complete photographic and radiographic documentation **(Figs 10a-10d & 11)**. He was invited for post-treatment photography six months later **(Figs 12a-12c)**.

Summary

For young patients, Class IV direct resin restorations are an excellent treatment modality for restoring fractures of anterior teeth, especially central incisors. This case illustrates how direct composite resin can be used to provide an excellent and minimally invasive restoration that will clearly benefit the long-term biomechanical behavior of affected teeth.

The patient and his mother were extremely happy to have avoided a more invasive crown preparation and could not believe that the restored part of the fractured tooth was virtually undetectable from the surrounding natural dentition.

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Figure 10a: Postoperative close-up right lateral view.

Figure 10b: Postoperative 1:2 full natural smile view.

Figure 10c: Postoperative 1:2 retracted frontal view.

Figure 10d: Postoperative 1:2 occlusal view.

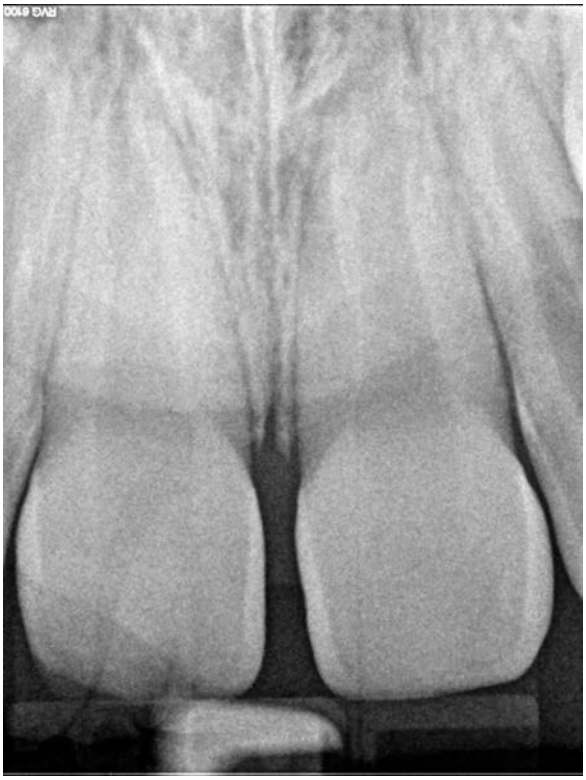
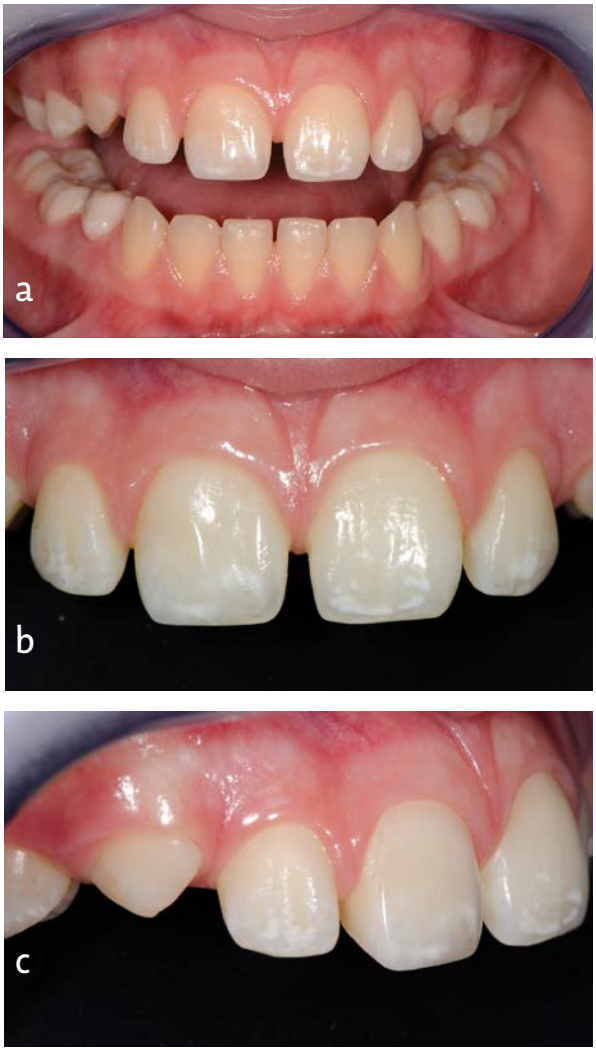


Figure 11: A periapical radiograph reveals no root fracture and satisfactory composite adaptation.



Figures 12a-12c: Six-month post-treatment clinical images. Note healthy gingival tissue and good marginal integration.

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Disclosure: The author did not report any disclosures.

Examiners' Commentary

Passing the "Litmus Test"

Class IV Direct Resin Restoration: Fracture Case

James H. Peyton, DDS, FAACD
Illustration by Zach Turner

> "This is everyday dentistry that many patients need and should be able to afford."

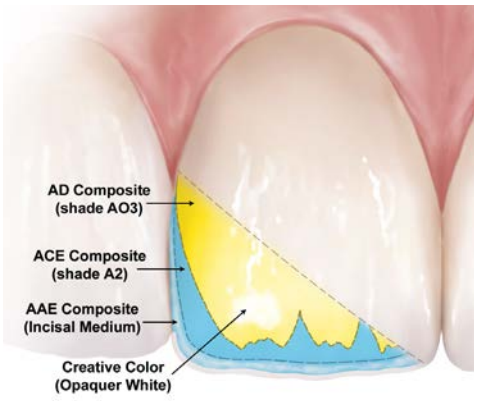


Figure 1: The color map details the layering process of the composite resin.

The Class IV fracture repair is one of the most common and relevant case types for AACD Accreditation. This is everyday dentistry that many patients need and should be able to afford. The ideal patient for this type of treatment is like the young boy discussed in Dr. Ivance's article. Many dentists do not take the time to learn a polychromatic layering process and finishing and polishing techniques that can yield natural, lifelike results. What a shame it would be to "grind down" a tooth like this for a full crown. In this case, a well-done composite resin can look better, be less traumatic to the pulp, be more conservative, and yes, the restoration can last a long time! The dentist can be a true artist and is in complete control of the situation. A great way to increase your skill in mastering composite resins is by taking hands-on courses at the AACD scientific sessions.

Dr. Ivance did an excellent job with this case, handling the composite resin and blending the restoration into the natural tooth structure. The color selection was well done. The milky-white incisal halo and incisal translucency mimicked the contralateral tooth. The white opaque effect was just slightly overdone, but it was very close (and it is not such an easy thing to accomplish) **(Fig 1)**.

This Class IV fracture case was passed by all of the examiners. However, some of their deductions were as follows:

- Criterion #61: Visible margins on the restoration.
- Criterion #44: Surface finish and polish did not mimic that of contratateral tooth.
- Criterion #86): Tooth #8 slightly longer than tooth #9.

This case demonstrated clinical excellence and deserved to pass. However, the restoration was not perfect (few cases, if any, ever achieve perfection). A good "litmus test" for the Class IV fracture case is "Can you see the restoration?" If you have to look closely to see where the restoration is, then the case should pass. Dr. Ivance's case passed the "litmus test" for this Accreditation case type. **jCD**

Dr. Peyton is an AACD Accredited Fellow and has been an AACD Accreditation Examiner since 2000. A part-time instructor at the UCLA School of Dentistry, he practices in Bakersfield, California.

Disclosure: The author did not report any disclosures.

WHAT'S IN A *Smile?*

THE CAPTURE OF EXPRESSION

Jason S. Olitsky, DMD, AAACD

Figures 1-3: Inspiration for a studio session comes from the personality of the subject. Great portrait images of patients have a positive energy and display a "feel-good" emotion that radiates from a confident smile.

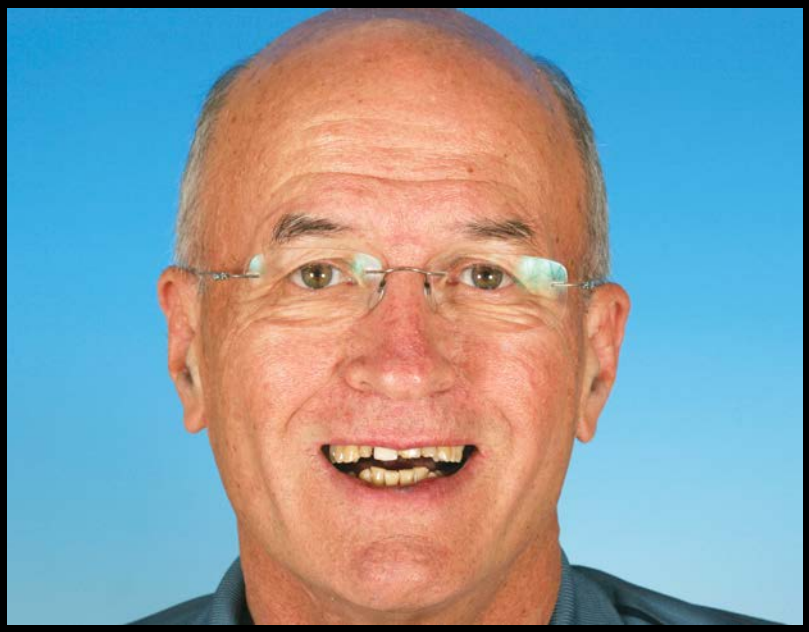
INTRODUCTION

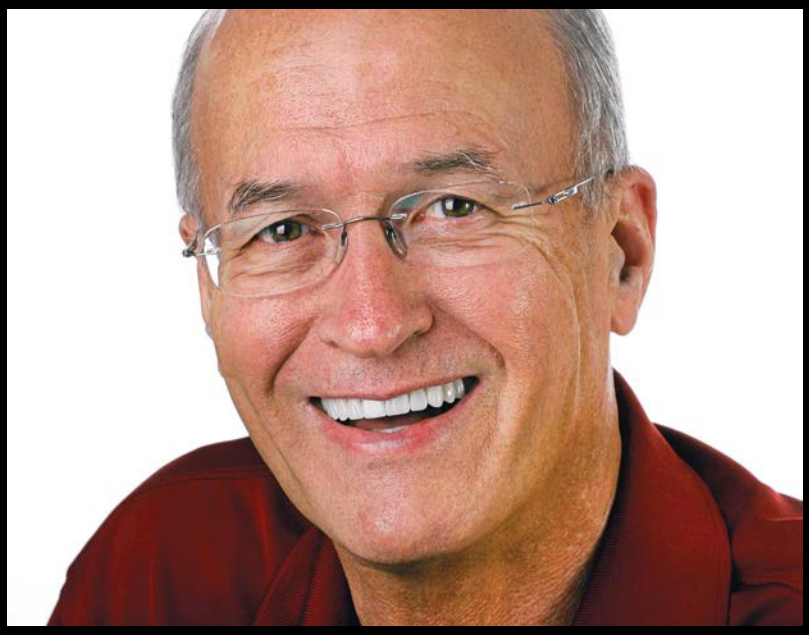
A smile begins and ends with emotion. Everything else is just details. Emotion dominates the frame of a digital single-lens reflex (DSLR) camera aimed at a new patient who is uncomfortably showing teeth that have yet to be transformed. Emotion of a different nature is captured in a patient who proudly reveals a confident new smile. The smile is our inspiration, emotional and revealing **(Figs 1-3)**.

If we have not accurately addressed the emotion in the beginning, then the details don't matter. The details, such as treatment planning, smile design, and occlusion, dominate the case,[1] but it is emotion—the concern about not having a pleasing smile—that has brought the patient to our office. The appearance of our teeth has the potential to communicate our health and attractiveness. If an individual has "bad teeth," it can be socially crippling. Studio photography is an opportunity to capture the feeling of a patient who has a new smile and leverage it to engage new clients, as well as affirm that patient's decision to invest in their teeth. Each portrait tells that individual's story of how it felt to hide their smile and their feeling about having an attractive smile for the first time in their lives **(Figs 4 & 5)**.

THE CRITICAL NATURE OF LIGHT

Light is the essence of photography. It is energy in the form of electromagnetic waves visible to the human eye.[2] To utilize flash photography to properly illuminate teeth, smiles, and faces, we must understand how light acts in nature. An open flash emulates the light we see from the direct sun; harsh and unflattering with strong shadows and high contrast. The light has well-defined edges and strong shadows, which are "hard" light qualities. A diffuser used to soften the flash resembles light on an overcast day. The light appears to be coming from an indiscriminate source with no hard edges. It has softer shadows, which enable the visualization of details, and less contrast encompassing a range of tones. These tones fall into categories, highlights, mid-tones, and shadows.[3]





Figures 4 & 5: High-quality portraits communicate that the dentist cares about the dentistry. "After" portraits help to affirm the patient's decision to invest in a new smile.

THE SMILE *is our inspiration,* **emotional** *and revealing.*

Setting up lighting in a studio can be very simple. One light can be used to create a flattering look if positioned properly, but communication is what makes an engaging picture work as an emotional testimonial. Single-light setups are usually positioned near the camera for best effect. Side lighting with a single light will produce deeper shadows with more contrast on the opposite side of the face, revealing only highlights and shadows. It will require reflection to see details in the shadows. Reflectors are commonly used to create "fill" light on the opposite side of the face. Silver or white reflectors are used in the studio.

A macro twin or ring light source is small and unmodified. Similar to a pop-up flash, the light is unflattering. These light sources can be diffused by putting translucent materials between the light source and the subject. The material diffuses and spreads the light over a larger area. The farther the diffuser is placed from the flash, the larger the light source will become. This further diffuses the light source, which softens the shadows and increases the shadow details. There are many different types of diffusers available to soften light; a softbox is one type that has the effect of creating a softer, larger light source from a studio strobe.

Speed lights can been fitted with diffusers, similar to studio strobes, such as bouncers and softboxes, to create a larger light source.[4] Macro ring flashes do not currently have ready-made solutions for diffusing the light; however, they easily detach from the lens and can be positioned behind a diffuser to soften the light **(Figs 6 & 7)**.

TAKING THE IMAGE

Studio photography should be thoroughly planned; a specific goal is essential for a shoot to be successful. Perhaps the goal is a certain look, pose, or expression that requires the use of a makeup artist or prop. A collection of pictures depicting people with expressions, poses, or looks can serve as inspiration for studio photography sessions **(Fig 8)**.

Figures 6 & 7: A Canon MR-14EX macro ring flash is held off camera and diffused through the translucent material of an inexpensive umbrella. A silver reflector bounces light onto the opposite side of the model's face to further increase shadow detail.

Figure 8: When using images for marketing and promotion, makeup artists and art directors often can contribute to the overall look. Here, Whitney Thompson, 2008 winner of "America's Next Top Model," is photographed in studio with a three-light setup.

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Capturing angles of teeth that are more flattering or show off the completed smile is imperative to finishing the case. An example of a flattering angle has the central incisors at a 90-degree angle to the camera with a smile that evenly lights both buccal corridors. Communicating with the subject to position their head at various angles to the camera can create more emotionally captivating images that have potential to ideally display the teeth.

Portrait photography is an opportunity to connect with our patients' emotional sides and bring out their feelings of what it's like to have a new smile. Decisions are made emotionally and instantly. Beyond studio strobes, backgrounds, and camera settings, it is not enough to have a subject sit in the typical position with head horizontal, tell them to "Smile," and hit the shutter release button. Good dialog for "after" portraits centers around how the patient's life has changed since improving their smile. A picture of an authentic smile tells a story about what it's like to finally smile confidently without fear of being misjudged **(Figs 9 &10)**.

Figures 9 & 10: Obtaining images that act as authentic testimonials requires proper communication with the patient. Simply telling the patient to smile does not communicate the same story as a picture of a patient truly enjoying a new smile.

Figures 11-13: Smile design principles such as facial midline discrepancies and width:height ratios can be shared with the patient.

Studio photography can also be used to enhance the details of a case. Capturing full-face information and macro images with studio-modified light makes treatment planning more engaging for laboratory technicians, specialists, and restorative dentists. Digital smile design from captivating images can be shared with patients to help them understand realistic results and possible limitations in cases, such as midline discrepancies, that might remain unchanged in the final results **(Figs 11-13)**.[5] Teeth of more ideal proportions can be compared to a patient's actual teeth to determine the exact amount of change required before commencing. Results can be evaluated to determine if objectives were met and where improvements can be made for future cases.

SUMMARY

Dentists must pay attention to the details of cases; however, it is also important to give adequate consideration to what could potentially be the most important emotional components of the case. The way teeth and smiles are objectively and subjectively interpreted by a dentist ultimately affects and directs the details of a case. Studio photography can place an emphasis on the subjectivity and objectivity of a case and can be used to gather emotional and detail information to properly begin and finish a smile.

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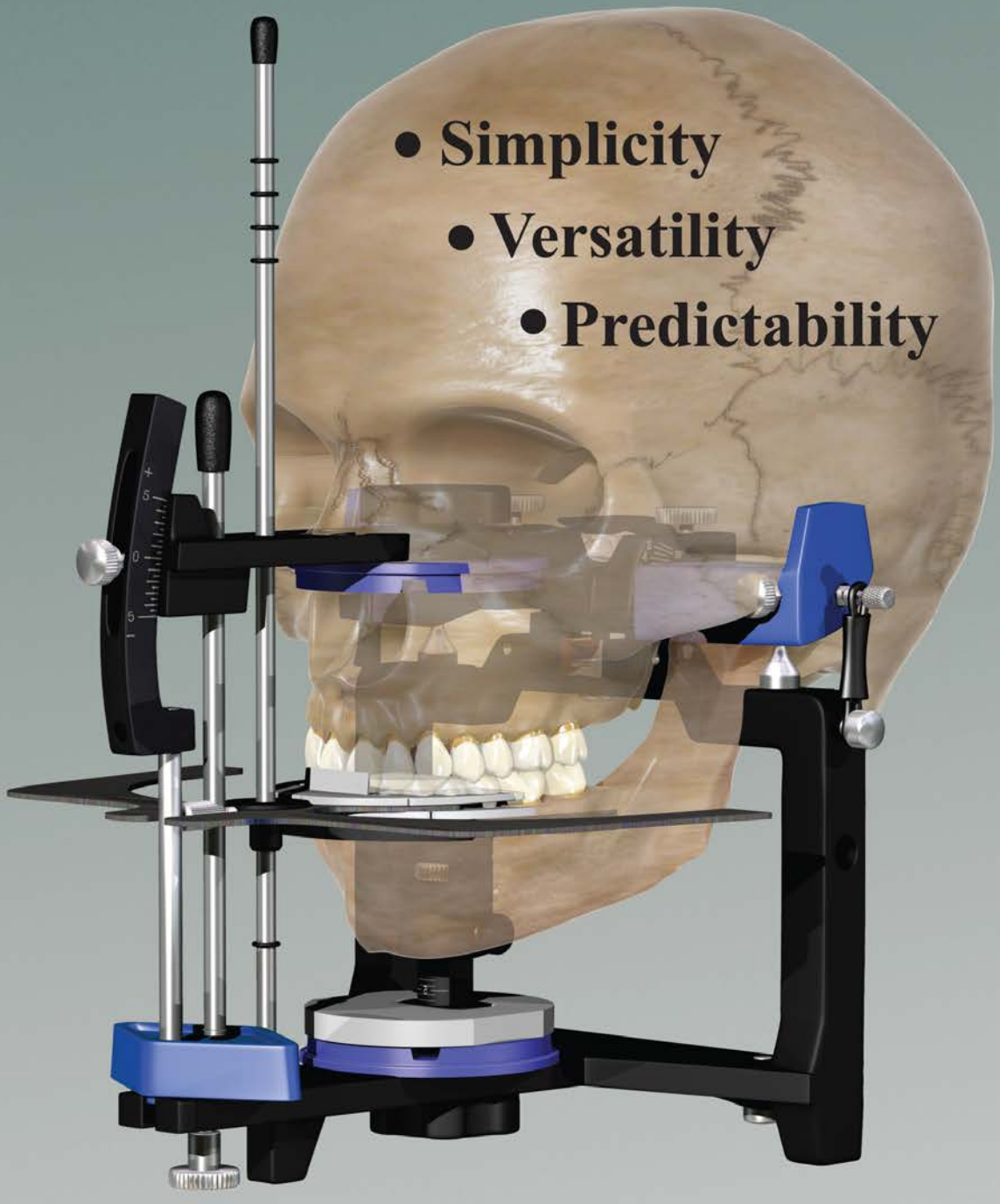

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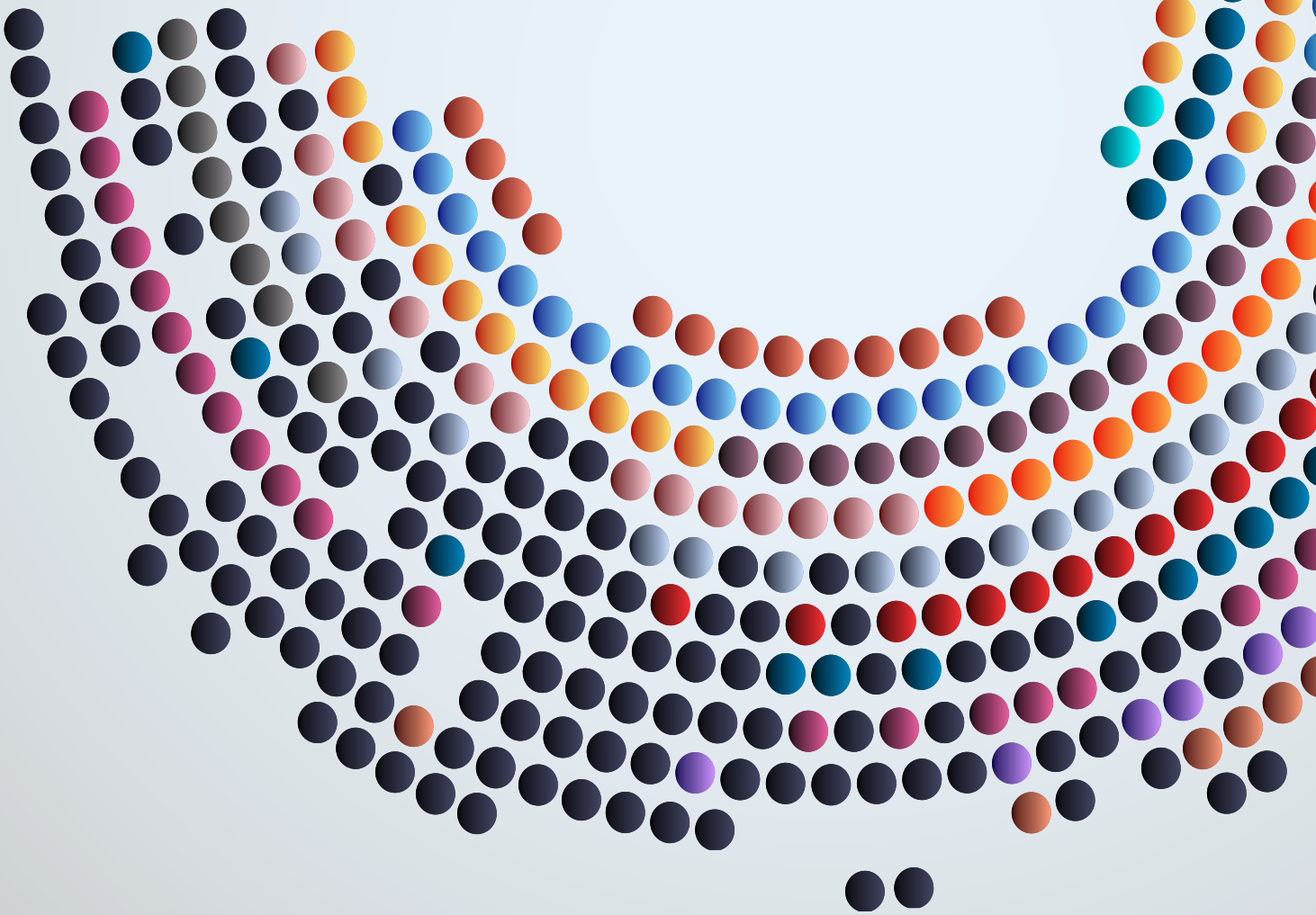
Chromatically

Shade matching artificial restorative materials to the natural dentition remains perplexing for the novice, and challenging for the experienced clinician.



Crafted Restorations

Shade Matching With Resin-Based Composites

Irfan Ahmad, BDS

Abstract

There is little doubt about the esthetic benefits of resin-based composite (RBC) restorations in both anterior and posterior teeth. However, precise shade matching, or masking prevalent tooth discoloration, still remains an elusive task. The difficulty in providing a restoration that impeccably mingles with the surrounding tooth substrate and dentition is taxing and complex. Firstly, teeth are in a perpetual state of chromatic flux; and secondly, a thorough understanding of color, optical properties of natural teeth, and artificial composite materials are requisite for avoiding pitfalls and disappointing outcomes. Using a case study, guidelines are presented for circumventing clinical obstacles by a methodical and systematic approach for shade matching composites with surrounding natural tooth substrate and dentition.

Key Words: Chromatic properties of teeth and RBC, RBC shade-matching guidelines, dental photography, chromatic mapping, incremental layering

Chromatic Properties of Teeth and RBC

The description of the perceived color of an object is "indescribable" and always relies upon references to other entities or analogies (e.g., black may be described as "blacker than the raven wings of midnight" [Edgar Alan Poe, *Ligea*, 1838], while red may be compared to "the three infernal Furies stained with blood" [Dante Alighieri, *Inferno*, c. 1314]). Furthermore, the ability to convey what one sees or feels to another person is not only an art, but also a miracle!

The color spectrum of natural teeth occupies a very small part of the visual spectrum,[1] or color space, located between the +a* (red-green) and +b* (blue-yellow) chromatic coordinates of the CIE L*a*b* color space (i.e., in the red, red-yellow (orange) and yellow wavelengths of the spectrum).[2] It also is worth noting that 80% of natural teeth belong to the Classic Vita A shade tabs (Vident; Brea, CA).[3] Despite occupying this narrow range of color space, shade matching artificial restorative materials to the natural dentition remains perplexing for the novice, and challenging for the experienced clinician.

Natural teeth[4,5] and artificial restorations[6] are in a continual state of chromatic flux, meaning that the shade is constantly changing throughout life. A natural tooth has different optical properties compared with artificial resin-based composite (RBC) materials.[7] The shade of a natural tooth is determined by the color of dentin and enamel, as well as the translucency of the latter. In addition, the fluorescent properties of dentin and opalescent qualities of enamel also influence the perception of the tooth shade. Youthful enamel is reflective, thicker with a higher value (greater luminosity), and therefore reduces light transmission to the underlying dentine layer. On the other hand, aged enamel has lower reflectivity and is thinner and more translucent, allowing greater light transmission to reveal

Table 1: Guidelines for Shade Matching RBC Restorations.

Checklist	Clinical Protocol
Prophylaxis	Remove superficial stains, biofilm, saliva, and dry but not desiccate teeth.
Timing	Preferably following tooth preparation (if clinical situation allows) to access the dentin color and gauge depth of the cavity for determining thicknesses of composite layer(s) for color matching, or masking discoloration.
Choice of materials	In the author's opinion, it is prudent to avoid mixing shades of RBC from different manufacturers in a single restoration. The rationale for the latter is that there is rarely congruence with respect to handling characteristics, optical properties, or a given shade (and opacity/translucency) from different manufacturers. Hence, it is advisable to familiarize oneself with a particular composite and exploit its properties to maximum effect. Use bonding agents, polishing recommendations, and armamentarium from the same manufacturer as the RBC.
Visual direct shade assessment	Prior to isolating teeth, place various shades and thickness of composite directly onto dentin and/or enamel for optical connectivity. Assess color match or masking ability after light-curing the test increments. Change shades and thickness of layers, as necessary, to obtain desired result.
Illumination	Use standardized illumination of correct quality and quantity, e.g., a diffuse light source of color temperature 6500K (daylight)[14] and 2000lux intensity. A second light source of color temperature 3000K (tungsten light) may be used to mitigate metamerism. Change angle of illumination or ask patient to move head to view tooth from different angles for assessing goniochromatic effect.[15]
Neutral and relaxed environment	Avoid lurid background colors, or use 18% neutral gray card. Carry out shade assessment in a serene and tranquil environment.
Hue accommodation	Limit shade assessment to five seconds.
Photography	Excellent for analyzing morphology, surface texture, and drawing characterization and chromatic distribution maps for guiding incremental layering, but not useful for shade analysis, which should be verified by visual direct shade assessment.
Polishing	Follow a standardized protocol and armamentarium for a specific composite.

the color of the underlying dentin.[8] RBCs are heterogeneous materials composed of a matrix interspersed with filler particles, and their color is influenced by hue, chroma, translucency, fluorescence, and opalescence. Hue and chroma are achieved by addition of dyes within the matrix, while translucency depends upon the composition of the resin matrix,[9] the size and amount of filler particles,[10] the hue of the selected shade,[11] cross-section thickness,[12] mode of polymerization, and ageing of the material over time.[6]

Shade Matching RBC

Therefore, at the time of providing a tooth-colored restoration, either direct or indirect, the color assessment is merely a snapshot of the shade at that moment in time. In addition, a composite restoration matching the tooth shade at a given time should be regarded as ephemeral rather than eternal. Furthermore, shade-taking for direct and indirect restorations are entirely different processes due to the nature of the materials and type of restorations. The ability to shade match a composite depends upon its hue, chroma, opacity, translucency, and thickness of the incremental layers. Visual shade assessment, rather than instrumental, is still the preferred option but is affected by clinicians' individual factors such as training, color blindness, etc. Shade analysis is best performed in a relaxed ambience, limited to no more than five seconds to avoid color adaptation or hue accommodation.[13] **Table 1** summarizes the pertinent guidelines for shade matching RBC.

Clinical Case Study

Diagnosis and Preparation

A 64-year-old female tripped on stairs while rushing to catch a train and fractured her left maxillary central and lateral incisors **(Fig 1)**. The upper lip showed minor lacerations and tetanus inoculation was confirmed. The trauma resulted in detachment and loss of the incisal edges, leaving sharp serrated margins, exposing the underlying dentin and white calcification areas and visibility of fracture lines within the enamel layer. Since the fractured defects (Class IV lesions) had no tooth substrate background, opaque composite layers

Figure 1: Preoperative view of fractured left maxillary central and lateral incisors.

> "Both natural teeth and artificial restorations are in a state of perpetual chromatic flux, and therefore the color of any restoration (direct or indirect) should be considered transient rather than permanent."

were necessary to block the darkening effect of the oral cavity. A periapical radiograph confirmed that the fracture was isolated to the coronal part of the tooth without root involvement. The central incisor was asymptomatic, but the left exhibited hypersensitivity to thermal stimulus and slight tenderness in the buccal sulcus. Due to these innocuous symptoms, it was decided to review and monitor both teeth, and the patient was informed of possible future endodontic complications and intrinsic discoloration.

The ideal treatment modality for this case was direct composite restorations to restore health, function, and esthetics.[16] The chromatic and characterization analysis revealed thin grayish enamel overlay with a smooth shiny surface encouraging specular reflection **(Fig 2)**. Due to the thinning of the enamel, the high chroma dentin color was blatantly visible. All these features are consistent with an aged dentition.

To prevent laceration of the upper and lower lips during speech and mastication, the sharp edges of the fracture junction were judicially smoothed with aluminium oxide discs. Bleaching was offered prior to the restorations, but due to the patient's constraint of an upcoming family wedding, she opted to forgo tooth whitening and proceed with the direct composite fillings. The patient was also asked to provide photographs of her intact teeth before the accident, but was unable to locate any at short notice. Initially, the tenacious calculus buildup compromising periodontal health was removed by deep scaling, and prophylaxis polishing removed all extrinsic stains.

Shade Assessment

The choice of composite is empirical, depending upon individual preferences or penchant for a specific product or manufacturer. There are numerous materials on the market, all offering a variety of shades, opacities, tints, etc. However, as mentioned earlier, rather than using several composites, it is beneficial to gain experience with a given product and understand its unique handling and chromatic properties. Following periodontal therapy, a visual direct shade assessment was performed using Premise (KerrHawe SA; Bioggio, Swit-

Figure 2: Preoperative view of fractured left maxillary central and lateral incisors. The abraded facial surface of the maxillary teeth has resulted in smooth, shiny surfaces that encourage specular reflection.

Figure 3: Visual direct shade assessment using dentin and enamel layers of composite. The composite layers on the left lateral incisor blend better than those on the left central incisor.

zerland), by placing two consecutive layers onto the labial surface of the hydrated and moist teeth as follows:

- On the left central, starting at the cervical aspect, an initial 0.5-mm layer of Premise A4 Dentine (A4D) was placed and covered incisally with a 0.5 mm layer of Clear shade.
- On the lateral incisor the initial layer was 0.5 mm A4D, which was covered incisally with a second layer of Grey shade.
- The test layers were light-cured,[17] sprayed with water to obtain optical connectivity, and then viewed with standardized 6500K diffuse illumination **(Fig 3)**.[18,19]
- The composite layers on the left lateral blended better with the surrounding tooth substrate compared to those on the left central incisor, and it was decided to proceed with the former combination (i.e., A4D and Grey shade).

Photography

As stated in **Table 1**, dental photography has limited use for shade assessment, but is invaluable for assessing and drawing characterizations and chromatic distribution within a tooth. The best approach for more clearly visualizing the latter is manipulating a preoperative image, preferably devoid of surface specular reflections that may obscure the underlying dentin, by using photo-manipulation software, such as Aperture (Apple; Cupertino, CA) or Photoshop (Adobe; San Jose, CA).[20] The manipulation is relatively simple, involving increasing contrast and decreasing brightness, which enhances characterizations and chromatic distribution within a tooth **(Figs 4 & 5)**. The manipulated image is then used to create a characterization/chromatic distribution map **(Fig 6)** for guiding composite incremental layering in conjunction with the visual direct shade assessment carried out beforehand. Also, the bucco-lingual thicknesses of the teeth are measured to calculate the thickness of the composite increments. In this instance, the thickness of the left central incisor at the cervical aspect of the fracture was 3.5 mm (distal aspect), tapering to 2 mm at the incisal edge (mesial aspect), while for the lateral incisor the thickness was 2 mm at the cervical aspect of the fracture (mesial aspect), and tapering to 1 mm at the incisal edge (distal aspect).

Treatment

Ideally, a diagnostic wax-up followed by fabrication of a silicone matrix would have made an excellent template for creating palatal walls for the incremental layering, but limited time did not afford this luxury. Instead, the restoration was commenced freehand.

Figure 4: Correctly exposed preoperative image.

Figure 5: Photo manipulation of a preoperative image by increasing contrast and reducing brightness, which highlights the inherent characterizations and chromatic distribution within a tooth. Also, notice the clearly visible fracture lines within the enamel layers.

Figure 6: A characterization/chromatic map for guiding composite incremental layering in conjunction with the visual direct shade assessment carried out earlier (see Figure 3).

Figure 7: Facial view of the initial 0.5-mm Premise Grey shade layers forming the palatal walls.

Figure 8: Palatal view of the initial 0.5-mm Premise Grey shade layers forming the palatal walls.

Figure 9: Premise A4D and Clear shades for simulating the incisal and interproximal halos and translucencies, respectively.

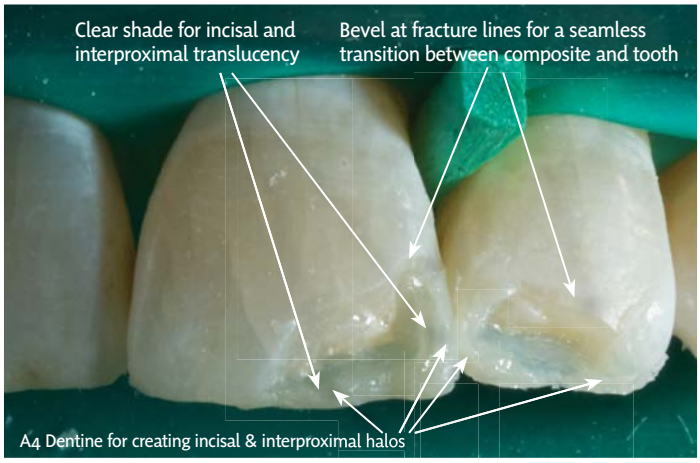


Figure 10: Using the characterization/chromatic map (Figure 6) as a guide, incisal and interproximal halos and translucencies are simulated with appropriate shades of composite increments.

Figure 11: Internal characterizations within the dentin layer of the stratification buildup.

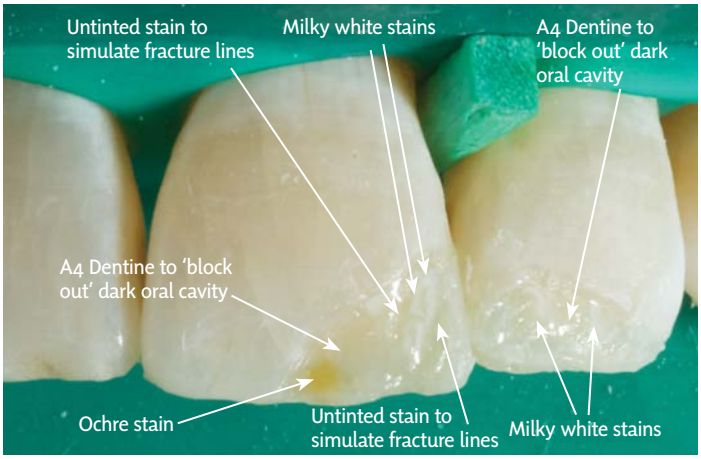


Figure 12: Using the characterization/chromatic map (Figure 6) as a guide, internal characterizations within the dentin layer of the stratification buildup with precisely applied stains and tints.

The teeth were isolated with rubber dam, using FixoFloss (KerrHawe) at the distal aspect of the canines, and a wooden wedge (Hawe Sycamore Interdental wedges, KerrHawe) placed between the central and lateral incisors to transiently separate the teeth to achieve a tight interproximal contact area. Minimum tooth preparation was necessary, limited to creating a 360-degree bevel with a chamfer bur around the fracture circumference, for improved blending of the composite reconstruction with the surrounding tooth substrate.

A self-etching, two-step dentin-bonding agent, XTR (KerrHawe), was applied onto the entire fracture lesions. If using a total-etch dentin-bonding agent, precursory etching with phosphoric acid is mandatory. To create palatal walls as platforms for the incremental layering, 0.5-mm Premise Grey shade layers were rolled out using a CompoRoller (KerrHawe), held in place with cellophane clear strips and subsequently light-cured **(Figs 7 & 8)**. Using the characterization/chromatic map as a guide **(Fig 6)**, increments of A4D were placed at the incisal and interproximal aspects to simulate halos. To create bands of incisal and interproximal translucencies, Clear shade was applied internal to the A4D increments **(Figs 9 & 10)**. Further layers of A4D were applied to block out the effect of the dark oral cavity; the thickness was approximately 2.5 mm and 1 mm for the central and lateral incisors, respectively. Internal characterizations were created within the A4D layers using the Kolor kit (KerrHawe) for milky-white patches, fracture lines, and ochre stains **(Figs 11 & 12)**. To complete the restorations, final overlays of 0.5-mm thick Grey shade were applied using a CompoRoller for smooth and uniform thickness coverings **(Figs 13 & 14)**.

Finishing and Polishing

Finishing and polishing was postponed for a few days to allow hydration of the teeth, to assess the shade of the composite restorations. The morphology of the composite restorations is not slavish copies of the contralateral teeth. Instead, unique incisal wear patterns were formed with OptiDiscs (KerrHawe) to account for differential tooth wear **(Fig 15)**. In addition, achieving a high-luster surface gloss, similar to the surrounding natural teeth, was relatively easy due to the high polishability of nanohybrid composites. The protocol involved using only one type of rotary polishers, Opti1Step polishing tips (KerrHawe), which simplifies the onerous polishing steps of an arsenal of burs, silicone tips, and polishing pastes advocated for many RBCs. Also, it is worth noting that the adjacent and antagonist natural teeth are misaligned, yet possess beautiful chromatic variance, differential incisal wear, and internal enamel fracture lines. The restorations attempted to emulate these prevalent anomalies, avoiding symmetry or a monochromatic appearance, which would appear "artificial," bland, and contrived.

Figure 13: The final layer of Grey shade being applied using a CompoRoller with a conical tip for a uniform thickness overlay.

Figure 14: The completed restorations are conspicuous due to the dehydration of the surrounding tooth substrate caused by isolation with the rubber dam.

Figure 15: One-week postoperative result after finishing and polishing, showing the unique morphology and characterizations of the composite restorations in the maxillary left central and lateral incisors. No attempt has been made to slavishly copy the contralateral teeth, which would create a contrived and artificially symmetrical appearance rarely seen in nature. Instead, the restorations are esthetic and blend with the adjacent and antagonist teeth.

Summary

Although resin-based composite restorations are highly esthetic, improper shade matching can result in poor outcomes. A thorough knowledge of tooth discoloration, color perception, and optical properties of natural teeth and composite materials mitigates pitfalls for a precise shade assessment. In addition, shade matching should circumvent clinical obstacles and have a methodical, standardized approach. Chromatically crafted restorations are possible by visual direct shade assessment to either match the existing tooth shade, or improve color by masking undesirable discoloration. Furthermore, shade analysis for direct restorations is different to that for indirect laboratory fabricated units. Finally, both natural teeth and artificial restorations are in a state of perpetual chromatic flux, and therefore the color of any restoration (direct or indirect) should be considered transient rather than permanent.

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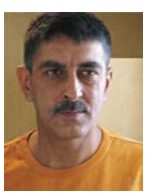

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A METHODICAL **Molar Buildup**

Pictorial Essay

Newton Fahl, Jr., DDS, MS

Abstract

Mimicking nature is not an easy task. Observing an object and breaking it down into its many dimensions is crucial for its true replication. This pictorial essay addresses the steps leading to the buildup of a first upper molar including roots and crown.

Key Words: Composite buildup, molar anatomy, fluorescence, occlusal, layering

Introduction

Esthetic dentistry looks to nature as a role model. Mimicking nature is not an easy task and requires knowledge, intense observation, and a great deal of dedication. Knowledge, obviously, is acquired through concentrated study of both fundamental and advanced concepts until they become ingrained in our consciousness. Observation is as much an art as it is a science. It requires a methodical protocol ranging from simple contemplation to the actual scrutiny and comprehension of that which is being visualized. Observing an object and breaking it down into its many dimensions is crucial for its true replication. It is only when we use both the left and right sides of our brain that we can break away from the linear cognitive analysis that renders our craftsmanship cold and impersonal to reach a warm, individual, and meaningful result. The interplay of form and color in the creation of a tooth is just as true as our ability to correctly interpret that which our eyes see and to correlate it with underlying knowledge. For this pictorial essay, I chose to build up a molar using my knowledge of anatomy, color, material science, and finishing and polishing techniques, softened a bit by my right-sided intuition to reach an outcome that would be true to nature, yet bringing to it a subjective, personal flair.

Light and shadow are an integral part of art. Because of this, I chose to use a Canon 5D Mark II camera (Melville, NY) with a Canon Macro Twin Lite MT-24EX flash mounted on a PhotoMed R2 dual point flash bracket (Van Nuys, CA). The flash setup allowed me to experiment with light intensities and orientation to obtain the best contrast and depth for each shot. Some of the shots were taken using a light shed for best light diffusion. Others were taken using a mirror to reflect the image and to allow for observation of the buildup from more than one angle. I also used an ultra-violet (UV) light when the work was completed to evaluate the varying levels of fluorescence of the composite resins used. This pictorial essay addresses the steps leading to the buildup of a first upper molar including roots and crown.

Figure 1: An extracted molar was used as a model for the shape of the roots.

Roots

Observation

I used an extracted first upper molar as a model for the shape of the roots **(Fig 1)**. The coronal portion of the tooth was carious but that did not interfere with the root anatomy. I spent considerable time observing the length, bulk, and curvatures of each root and tried to memorize each one individually and how they looked collectively. With the aid of a digital caliper, I measured the three dimensions of each one and started to build them up one by one.

Knowledge

Of course, knowledge of dental anatomy was paramount for this step, as we do not build entire roots clinically, and helped me interpret the slight variations there are among teeth. These included variations from the apical positions of foramina, and root orientation, to grooves and depressions along the root surfaces.

The composite selected for the root buildup was a hybrid (Herculite XRV A3 dentin, Kerr Sybron; Orange, CA). I needed a material that could provide the opacity and chroma as well as the physical properties of natural dentin. There are numerous composites available that could have been used for this step with similar results. Hydrated natural root dentin is usually monochromatic and may be spotted with a few areas of higher saturation or even present a minor uneven hue distribution.

Technique

I first rolled the dentin composite into three toothpick-like rods and polymerized them to serve as staves around which to build the root bulk **(Fig 2)**. The mesio-buccal, disto-buccal, and palatal roots were individually shaped into oversized forms and then light-cured. Each was properly finished with discs and rotary instruments to emulate the exact dimensions of their natural counterparts. Next, the three roots were assembled using the same dentin composite to bond them together at their most coronal site, near the intended cemento-enamel junction (CEJ) **(Fig 3)**.

Figure 2: A dentin shade of composite was used to form thin rods around which the roots were sculpted.

Figure 3: The roots were assembled at their most coronal site with the same dentin composite.

Crown

Observation

The upper molar crown surface is so curvilinear and rolling that we easily can become distracted when building both dentin and enamel. Therefore, I broke it down into the two distinct histomorphological components, to help my artistry stay true to nature.

Knowledge

I used an article by Bazos and Magne as a guideline for observing and sculpting the dentin morphology at the dento-enamel junction (DEJ).[1] The dentin is concave from the CEJ up to the cusp tips all around the crown. On the occlusal aspect it describes a concave curve as well, but with internal ridges and depressions that follow the outer enamel anatomy present on the occlusal table.

Technique

Using the same A3 dentin shade, I incrementally built up most of the coronal dentin and added a small amount of a higher chroma dentin of the same composite over parts of the occlusal aspect, so as to impart some polychromicity. Although the occlusal morphology was done almost completely by freehand, I had to sculpt in the more subtle details of the DEJ with burs **(Figs 4-6)**.

Figures 4-6: Dentin shades of different chroma were used to incrementally build up the coronal part.

For the circumferential aspects, I chose a hybrid achromatic, non-VITA enamel of milky-whitish appearance (Vitalescence Pearl Frost, Ultradent; South Jordan, UT). In the posterior teeth, achromatic enamels of higher particle size are ideal for mimicking natural enamel because they resemble the pearly-white look we often see in the middle and occlusal thirds, where the chroma is usually lower. As the enamel is thinner on the cervical third, it tends to pick up more of the dentin color from underneath, projecting a slightly higher chroma in that area. The artificial enamel was incrementally applied and light-cured until the desired morphology was achieved on all but the occlusal aspect. I strove to make the enamel layer increasingly thicker from cervical to occlusal third. The cusp tips were raised to their ideal height and the marginal ridges were positioned accordingly between them **(Figs 7-10)**.

Next, I used discs to finish the circumferential aspects to correct the emergence profile and cervico-occlusal inclination until the occlusal table had the right mesio-distal and bucco-palatal dimensions **(Fig 11)**. Burs were further used to refine the histomorphological characteristics of the occlusal dentin **(Figs 12 & 13)**. I then placed inner pits and fissures with a fine-tip bur to facilitate the application of tints **(Fig 14)**.

For the replication of highly saturated pits and fissures, I chose tints (Estelite Color, Tokuyama Dental America; Encinitas, CA), mixing ochre and brown to the desired chroma intensity. The mix was carefully flowed into selected areas so as not to make the tinting too even and unnatural-looking **(Figs 15 & 16)**.

For the occlusal layer, I chose a nanofill composite (Estelite Omega) of similar value to that which I used circumferentially **(Fig 17)**. The reason for selecting a different composite here was the better sculptability it offers for doing the occlusal anatomy in a single increment (the technique I favor). A lower-viscosity composite will tend to flow too much and therefore would need to be applied cusp by cusp. The latter is also a well-known and as-effective technique advocated by many.

Figures 7-10: Milky-whitish non-VITA enamel was applied to the circumferential aspects until the desired morphology was achieved, and the cusp tips were raised to their ideal height.

Figure 11: Discs were used to achieve the correct emergence profile and cervico-occlusal inclination, as well as the mesio-distal and bucco-palatal dimensions.

Figures 12 & 13: Burs were used to refine the histomorphological characteristics of the occlusal dentin.

> “Observing an object and breaking it down into its many dimensions is crucial for its true replication.”

Figure 14: Inner pits and fissures were sculpted with a fine-tipped bur to facilitate the application of tints.

Figures 15 & 16: Ochre and brown tints were used to stain pits and fissures to the desired chroma intensity.

The triangular ridges were sculpted to their functional convexity, rendering them higher in value than the fossae, pits, and fissures, as seen on a natural tooth. I used sharp contouring instruments to put in the sulci and pits, deepening them as I deemed necessary, to allow the underlying high chroma tint to show through **(Fig 18)**. This imparted a beautiful three-dimensionality to the occlusal surface of the buildup **(Fig 19)**.

As primary and secondary ridges frequently present marked opacity because of high-density white spots, I chose a high-opacity, high-value hybrid composite, shade Opaque White (Vitalescence) to build them. The composite was blended in to make the characterizations as subtle and natural as possible **(Fig 20)**.

As a final step, I revisited my buildup with a thorough visual inspection, checking for anatomical flaws. Minor touch-ups were carried out with burs to place surface texture and perikymata, and the final polish was done.

I further flowed a sparing amount of the ochre-brown tint mix into a few occlusal fissures and into the buccal and palatal sulci **(Figs 21 & 22)**. At this point, I also sprinkled some white tint (Estelite Color) on the cusp tips and marginal ridges **(Figs 23-25)**.

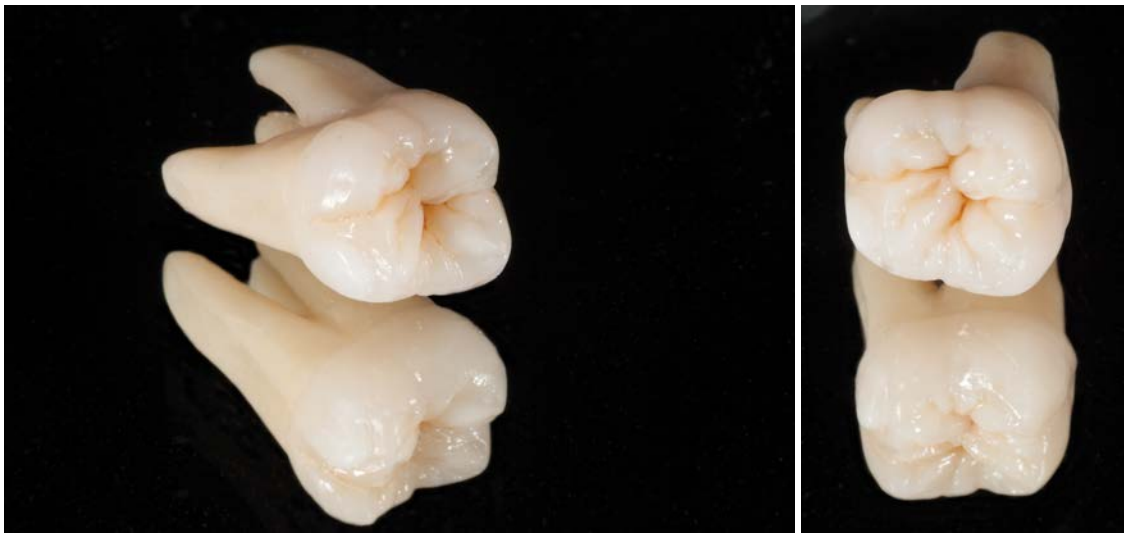
As "there is more to the picture than meets the eye," I spent time taking many photographs from different angles so that I could appraise the result in more detail. These also included shots under a UV light so I could compare the diverse levels of fluorescence among the composite systems used **(Figs 26 & 27)**.

Figure 17: For the occlusal layer, a nanofill composite of similar value to that which was used circumferentially was employed.

Figure 18: Using sharp contouring instruments, triangular ridges were sculpted and sulci and pits were deepened to reveal the underlying high chroma tint.

Figure 19: A beautiful three-dimensionality was obvious after sculpting the occlusal aspect.

Figure 20: A high-opacity hybrid composite helped create primary and secondary ridges with high-density white spots.



Figures 21 & 22: A sparing amount of ochre-brown tint mix was flowed into selective occlusal fissures and buccal and palatal sulci.

Figures 23-25: As a final step, flurries of white tint were sprinkled on cusp tips and marginal ridges. The views from different perspectives disclosed a nature-mimicking, artistic sculpture.

Figures 26 & 27: UV light was used to compare the diverse levels of fluorescence among the composite systems used.

Contemplation

The sculpture was finished. I set it aside for a few hours and returned to see if it would reveal any imperfections that I had missed. Unsurprisingly, there were a few things, both in form and color, which certainly could have been improved. I was pleased with my artistry but humbled by the fact that, despite all my knowledge and observation, I can only attempt to emulate the wonderful and precious work of God's hands.

> "The upper molar crown surface is so curvilinear and rolling that we easily can become distracted when building both dentin and enamel."

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Dr. Fahl has a Certificate in Operative Dentistry and a Master of Science degree from the University of Iowa. He is the owner and director of the Fahl Center in Curitiba, Brazil.

Disclosure: The author has consulted for Tokuyama Dental America in the development of Estelite Omega.

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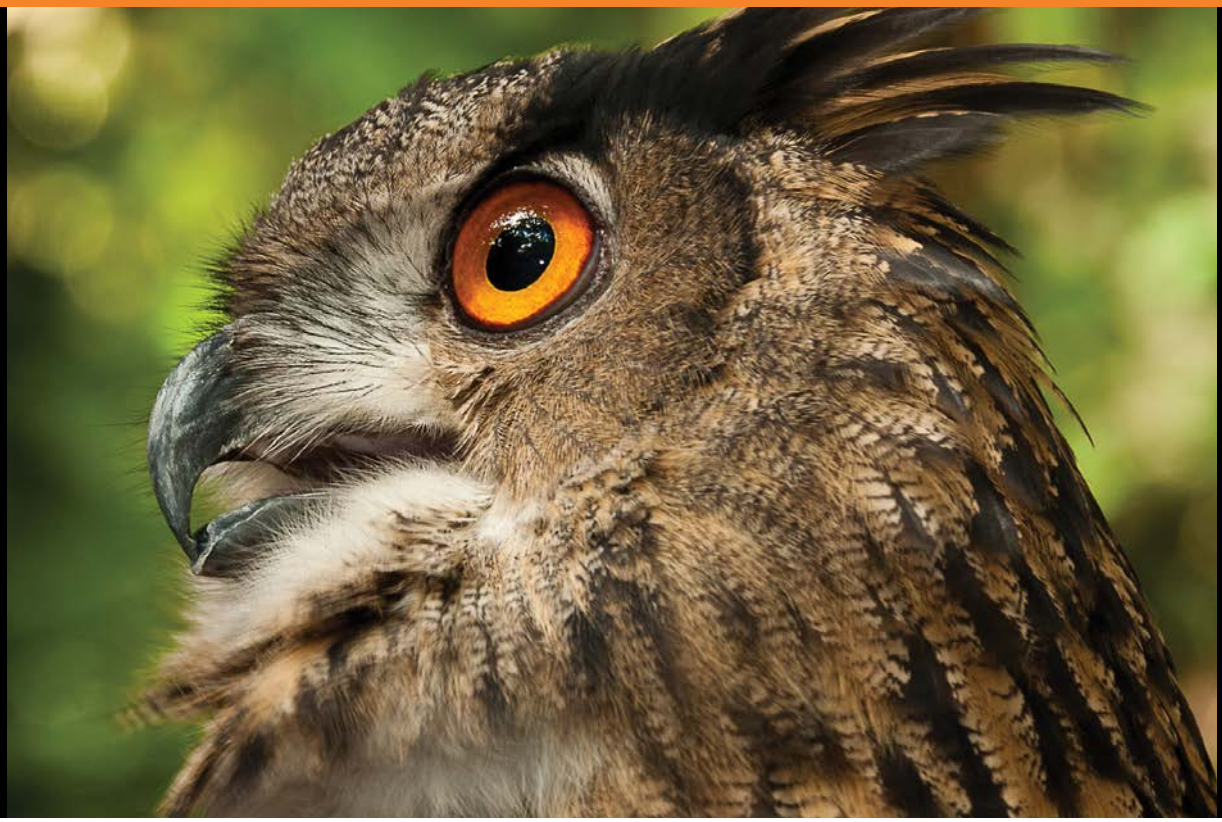
Myths vs. REALITIES



Owl (image captured with digital camera).

Fireworks over "Sleeping Beauty's Castle," Disneyland, Anaheim, California (image captured with digital camera).

It is important for clinicians to realize that they do not need to be master photographers to take good, esthetically pleasing pictures.

Compelling Authenticity and Detail of Digital Photography

Stephen R. Snow, DDS, AAACD

INTRODUCTION

In recent years, digital photography has come to the foreground in dental practices. The many advantages of incorporating digital photography span a range of functions, from patient identification during reception to medico-legal documentation during examination.

Digital photography also promotes faster case acceptance. When patients can view problems immediately, they feel more urgency to have necessary procedures performed.[1] Computer programs can be used to modify portrait images to help patients visualize possible cosmetic restorative outcomes for their own smiles.

It is important for clinicians to realize that they do not need to be master photographers to take good, esthetically pleasing pictures. Choosing a camera that is capable of performing the necessary functions for your practice does not have to be a confusing or daunting task. This article discusses some of the myths and realities of cameras and photography in dentistry.

Key Words: Digital photography, cameras, megapixels, RAW image format, camera settings

MYTH

Digital cameras must be expensive in order to take great photographs.

REALITY

The notion of expense is a relative one. Much like an investment in a quality handpiece or x-ray machine, a digital camera is a working tool that will facilitate better communication between you, your patients, your laboratory technicians, and your referral colleagues. With proper and consistent use, it will boost office efficiency and productivity. Dental photographs are most often taken at close range for enlarged views of teeth. Repeatable magnification is critical to be able to record cosmetic alternations in size and proportion with accuracy. A manual-focus macro lens is required to meet this need. Because the vast majority of cameras currently made do not have this type of lens "built in," it must be purchased and installed on a camera body that is designed to work with it. A digital single-lens reflex (DSLR) camera body is the most convenient and affordable option available now for use with manual-focus macro lenses. The DSLR camera body must also be able to control light appropriately for accurate color rendering and visual assessment. A separate flash system designed specifically to illuminate close-up work must be attached to the camera and lens as a part of that lighting system.

Of course, any camera can be used to take photographs of teeth, but only capable DSLR cameras that possess some important performance features (like those described above) will produce consistent and diagnostic images. Typically, manufacturers offer a few high-performance models in their product line. These cameras come bundled with a plethora of functions, options, and settings to allow the capture of spectacular images in even the most difficult or rapidly changing lighting conditions. Unfortunately, they also come "bundled" with a steep price tag. A "flagship" camera system outfitted with macro lens and flash can cost $10,000 or more. Although the images these cameras create are stunning, the elaborate setting options and elite processing speeds address photographic circumstances that are never encountered in the dental office. When purchasing a camera system for the dental office, clinicians understandably would prefer to minimize the expense. To meet this market demand, camera manufacturers also offer a few less expensive models for consumers who look at price—rather than performance—as the main criterion in the purchase decision process. Although the price is reduced, so is the number of available features that are included in these systems. The images they create may be acceptable for family vacations but are often unpredictable and frustrating for the dental office.

To capture good intraoral images, a moderately priced DSLR body is recommended; typically, that type of camera body costs between $1,000-$2,000 **(Figs 1 & 2)**. The manual-focus macro lenses usually cost about $600-$900. The focus flexibility and image clarity are best when the clinician selects the macro lens made by the same manufacturer as the camera body. In addition, close-up flash units that reduce the amount of reflected glare and produce accurate color at close range can cost $500 or more, depending upon the brand **(Fig 3)**. A practical and predictable digital SLR camera system costs approximately $2,000-$3,000 for body, lens, and flash strobe.[2]

MYTH

The greater the number of megapixels, the better the camera.

REALITY

This is probably the most heavily marketed feature of every camera, the sales hype being: If your camera has more megapixels, your camera is better and its photographs are *better*. Actually, the camera just has more megapixels, and its resulting images are *bigger*.

Certainly, camera sensors with more pixels are capable of capturing greater detail in each image, but does it matter? The most important consideration in determining how many pixels you need is determining how you will view the image after taking it.

Most contemporary computer monitors and high-density display televisions have 1920 x 1080 pixels (or about 2.1 megapixels) available for display. That's all. So, even if your image has considerably more pixels embedded in its file, your monitor can't display them. The extra pixels are simply unnecessary "overhead" that fills up space on your computer server faster **(Fig 4)**.

With prints, the general rule (varying depending upon brand and model) is that 300 pixels per linear inch are required to produce defined continuous tone pictures without actually seeing the "grainy"-looking individual pixels. For a 4 x 6 inch print, this amounts to 1800 x 1200 pixels (or still only about 2 megapixels).

It isn't a bad thing to own a camera with a greater megapixel count. More pixels allow you to "zoom in" to the image with computer software to enlarge its appearance without a loss in visible detail. Maximizing the number of megapixels, however, generally is unnecessary for routine image viewing in the dental office. Even base model digital cameras have more than enough megapixels to display and view clear images. For dental photography, other features are much more important.

This camera will be a functioning tool like any other in the operatory.

Figure 1: Moderately priced Nikon camera model with corresponding Nikkor 105mm macro-style lens mounted in place. This example has separate shutter speed and aperture control wheels to easily dial in the desired manual exposure setting.

Figure 2: Moderately priced Canon camera model with corresponding Canon 100mm macro-style lens mounted in place. Although designed in different positions than competing Nikon cameras, this model also comes with separate shutter speed and aperture control wheels to easily dial in the desired manual exposure setting.

Figure 3: This moderately priced Sigma dual-point flash system is a good example of a lens-mounted strobe designed to provide even illumination for both anterior and posterior close-up dental photography applications. Note that "modeling lights" have been activated here to help the operator focus on subject matter that would otherwise be difficult to see in ambient shadows.

Figure 4: This example of a high-end 4:3 aspect ratio computer display has 1600 x 1200 pixels (totaling only 1.92 megapixels). High-definition displays have 1920 x 1080 pixels (totaling only 2.07 megapixels). Additional pixels exceeding these totals would not be displayed.

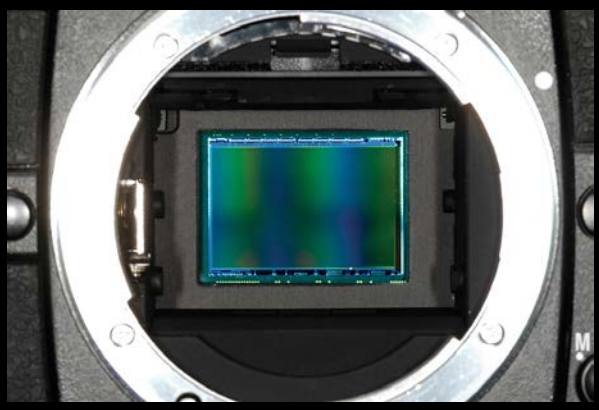


Figure 5: With the macro lens removed from the front of the camera body and the shutter release depressed, the light-sensitive sensor in the back of the camera body can be seen.

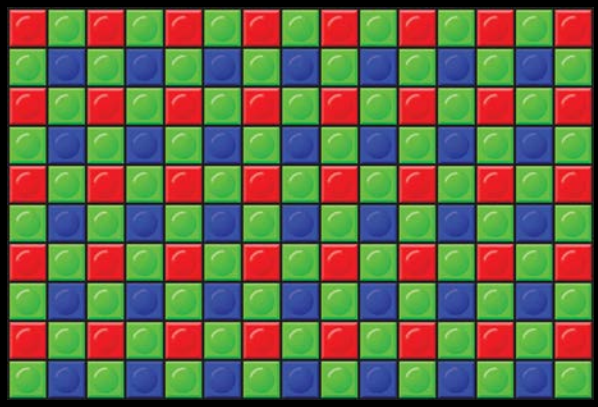


Figure 6: This graphic illustration of a magnified view of a DSLR sensor shows photosites arranged in a "checker board" pattern. Each photosite has an electrode that is covered with a red, green, or blue filter engineered to measure a narrow band of visible electromagnetic energy with a limited frequency range.

Figure 7: The exposure mode for this DSLR model is selected with a wheel located on the top of the camera. Program, aperture priority, and shutter priority are all automated light exposure settings, whereas the manual selection (shown here) allows the operator to control both the shutter speed and aperture to create intentional, repeatable, and predictable results.

Figure 8: Dental shade tabs in front of an illuminated white background were captured by a camera in aperture priority (automated TTL) exposure mode. The camera sensed the high proportion of light tones in the scene and underexposed the strobe lighting of the subject.

Figure 9: The same dental shade tabs and illuminated white background were then captured with a camera set to manual exposure mode. The high proportion of light tones in the scene had no effect on the manually selected camera settings and the resulting exposure results were ideal.

MYTH

Shooting RAW is appropriate for every situation.

REALITY

What is shooting RAW? When a digital camera captures an image, the shutter opens for a fraction of a second and light falls on a special computer chip in the back of the camera **(Fig 5)**. This sensor has a grid of photosites—each with its own light-sensitive electrode—that creates an electrical voltage proportionally to the amount of photons that stimulates it. This electric signal is sent to a digital-to-analog (D-A) converter and assigns a corresponding number to represent the light value captured by each photosite. A large number means that a larger amount of light saturated the cell, and a small number means that a smaller amount of light was captured. The individual photosites can only assess the presence of one primary color of light at a time: red, green, or blue (RGB) **(Fig 6)**. At this point, the color data for each pixel is incomplete, and the initial image is said to be "raw."

Before the image can be viewed in full color, the full RGB formula must be determined for each pixel. An additional color process (called demosaicing) must take place, in which computer algorithms infer the two missing colors for each pixel by comparing the data captured for adjacent pixels. As the final image file is formed, it is often assigned a format. Some formats (such as TIFF) retain all the color data of every pixel. The color visualized is the most detailed, but the corresponding image file is also the largest. Other formats (such as JPEG) actually discard some of the color data to help make the final file smaller. The ideal is to eliminate some of the color data without being overly noticeable on the computer display or print output.

Every RAW image must be processed before it can be viewed. If the photographer chooses to have that processing completed inside the camera, no additional effort is required. The RGB formulae for each pixel are determined, and JPEG or TIFF files are created by the camera's processor. The workflow is convenient, but color accuracy can be compromised and those results are permanent. If the photographer elects to process the RAW images outside the camera, additional knowledge, software, and experience are required. Each viewed image is actually a copy of the original file, which remains unaltered. The final color output can be the most accurate, but the process can be time-consuming.

Clearly, the RAW format provides the possibility for the most accurate and best-preserved data for a digital photograph. Since the original file cannot be permanently altered, RAW images are required for AACD Accreditation submission and are recommended for medico-legal documentation. For initial patient examinations and consultations, however, I am looking for speed and convenience. I often select internally processed JPEG image formatting to get the photographs from the camera's memory card to the computer display as efficiently as possible. When patients accept treatment, however, I take a small set of RAW pictures to record their pretreatment condition in a format that is indestructible.

MYTH

Setting your camera to automatic exposure, automatic focus, and automatic color control is guaranteed to give you the best results.

REALITY

When a camera is set to automatic exposure, automatic focus, and automatic color correction settings, it analyzes the data of the captured image and compares them to the data content of an "average/typical" scene as determined by the manufacturer **(Fig 7)**. The camera has been programmed to respond to any differences and perform a number of different functions that "correct" the image to make it more "ideal."

The camera manufacturers assume that a typical scene would include a multitude of light values and many different color hues. If you are taking photographs in circumstances like these, an automated setting works well. Dental images, however, do not fit the mold. Photographs of teeth in a frontal aspect retracted view will include a high proportion of white or light tones. If the camera is set for an automatic exposure mode, it will detect the dominance of highlights and inadvertently underexpose the picture, making it appear too dark **(Fig 8)**. If the same image is composed with lower camera alignment that visualizes more of the shadows in the back of the throat or a contrasting (black) background is placed behind the anterior teeth, the camera will sense an increase in percentage of dark tones and "correct" the image with an overexposure, making it too light **(Fig 9)**. These two photographs of the same subject would be very inconsistent. This problem (and associated unwanted outcomes) are common with Accreditation case submissions. Typically, patients have darker teeth before treatment and whiter teeth at the end of the case. In an automatic exposure mode, the camera has been programmed to respond to the disparity by modifying the images so that the teeth should appear to be the same. Accreditation candidates often produce unintentionally inaccurate representations of their patients' pretreatment circumstances and post-treatment results in terms of value.

The same is true for color. In an automatic white balance mode, the camera is programmed to evaluate color with the assumption that wide spectrums of hues are present **(Fig 10)**. If there is an overall tint detected in the image, the camera responds by automatically adjusting the color to yield a neutral result. Unfortunately, intraoral images include a high percentage of light yellow (teeth) and medium red (gingiva). When set to auto white balance mode, the camera will attempt to "correct" the color by adding blue and cyan (to neutralize the yellow and red respectively). This adjustment can cause the images to appear cyanotic or bluish-gray **(Figs 11 & 12)**.

If you use automatic focus, there also is no way of knowing how far you are from your subject. The camera will always adjust to correct the focus regardless of where you stand. Teeth can appear larger simply because you are standing closer to the patient as you capture the image. For Accreditation and medico-legal documentation purposes, it is critical to be able to accurately represent the maintenance or alteration of tooth size by utilizing a consistent magnification. The only way to ensure photographs are taken from the same distance is to use the camera's manual focus mode.[3]

Although it may seem counterintuitive, using automatic exposure, color, and focus settings will automatically guarantee that you get unwanted and inconsistent results with your dental photography. The use of manual exposure, white balance, and focus modes will automatically give you predictable and repeatable images.

MYTH

Cameras automatically capture color properly.

REALITY

The human eye adjusts to discern and identify color properly in any lighting circumstance. With incandescent bulbs, the light source can have a very orange hue; in fluorescent lighting, the hue of the light can be greenish; and outdoor in sunlight, the lighting is usually neutral without any tint. When the eye observes a scene under these conditions, the brain identifies objects that are white or neutral and determines the color of all other adjacent objects by comparison.

A camera can be set for color correction under different lighting conditions, but it must be set manually by the operator prior to taking pictures. As dental images in the dental office are almost always captured with flash illumination, I recommend setting your camera white balance to the "lightning bolt" icon—the universal camera symbol for "flash" **(Figs 13 & 14)**. The best accuracy in white balance is achieved through calibration of the entire camera system (body, lens, and strobe) by capturing a preset image of a neutral gray card and storing that setting in the camera's white balance library.

Figure 10: This DSLR model is designed with buttons that allow easy access to important camera performance settings including pixel count and formatting (QUAL), camera sensitivity (ISO), and, in this case, color compensation (white balance).

Figure 11: Dental shade tabs in front of an illuminated pink background (simulating gingiva) were captured by a camera with white balance set to "Auto." The camera sensed the high proportion of reddish color in the scene and added cyan to neutralize the image. The color of the shade tabs was simultaneously modified and inaccurate.

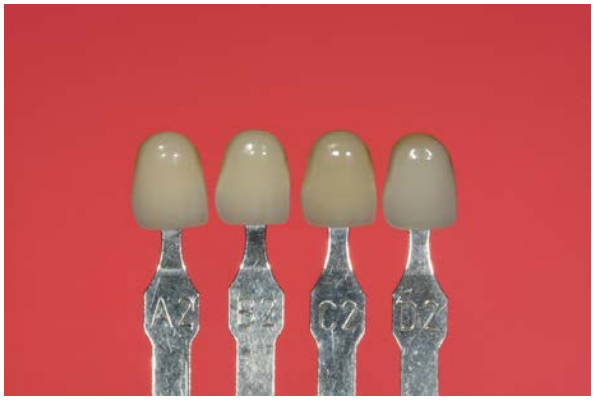


Figure 12: The same dental shade tabs and illuminated pink background were then captured with a camera with white balance set to "flash." The high proportion of reddish color in the scene had no effect on the camera's color interpretation and the rendered color results were ideal.

Figure 13: The menu system of this DSLR model has been activated to allow display of the possible white balance settings and to select the "flash" ("lightning bolt") option.

Figure 14: Most contemporary DSLR camera bodies display confirmation of the current white balance setting in a window on top of the camera or in an information display on the back. (See the lightning bolt icon representing the "flash" setting in the center of this image.)

Figure 15: Honey bee in flight (image captured with digital camera).

MYTH

Digital cameras have greatly improved through the years, but the images they produce still lack the overall compelling nature of film photography.

REALITY

Most digital processing and film chemistry is designed purposely to enhance and increase contrast and color saturation. That is a nice feature if you are photographing a landscape or other scenery, but when photographing teeth, the objective is to capture an accurate representation of color and characteristics on a scientific basis. Therefore, the image needs to be as realistic as possible. Over-processing with exaggerated color saturation or contrast is a fast way to destroy an otherwise correct photograph.

Both traditional film photography and digital photography are capable of producing precise photographs. With the amount of photo processing software currently available, digital photographs can arguably be just as—if not more—compelling than film **(Figs 15-18)**.

CONCLUSION

The most important thing to be aware of when incorporating digital photography into the dental practice is that if you purchase an inferior camera that does not have all the functions necessary to capture the types of photographs you will be taking, you will only be adding frustration and wasting valuable clinical time. Remember, this camera will be a functioning tool like any other in the operatory. Just as you would not risk buying instruments or x-ray machines that would inconvenience the dentist or staff, the same should hold true for your digital camera.

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Figure 16: Billy Ocean in concert (image captured with digital camera at a public event).

Figure 17: Billy Ocean in concert (image captured with digital camera at a public event).

Figure 18: Starship in concert (image captured with digital camera at a public event).

Dr. Snow practices in Danville, California.

Disclosure: The author did not report any disclosures.

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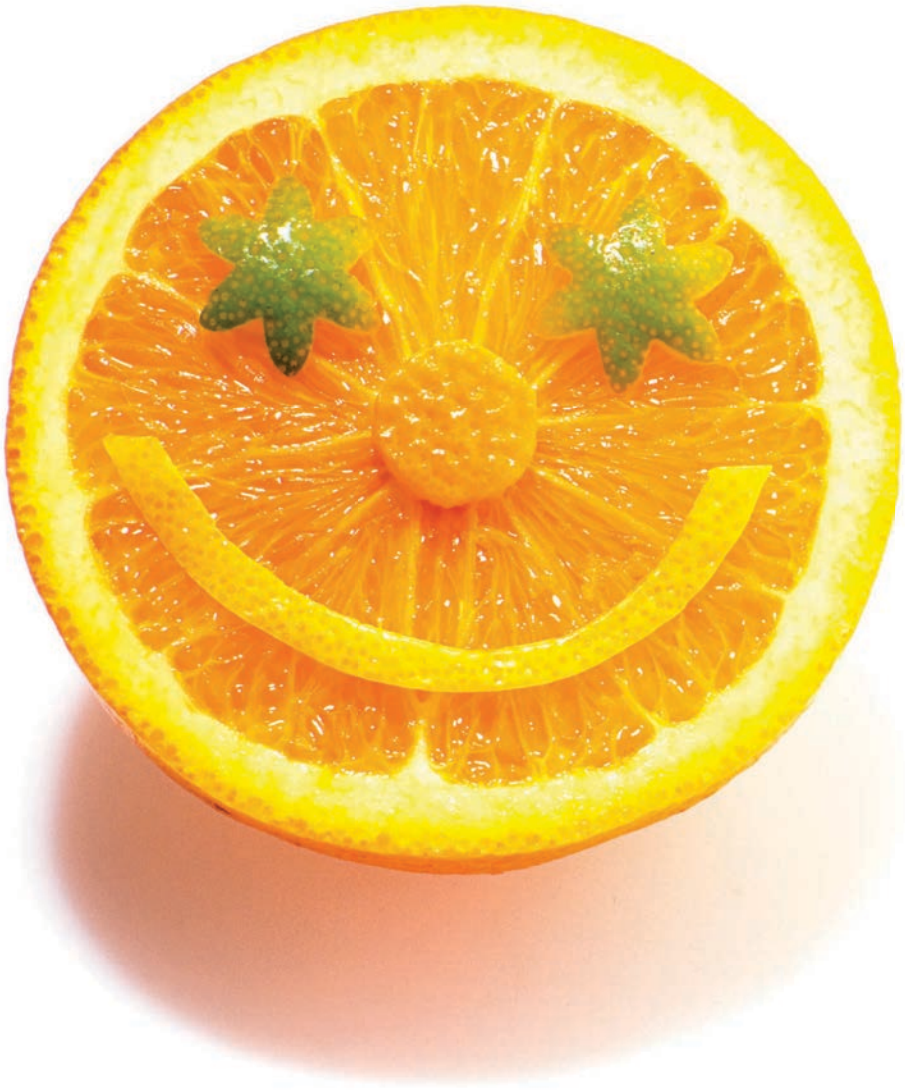

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18 Tips

Refine Your Dental Photography

A Quick Guide to Quality Images

Todd C. Snyder, DDS, AAACD

Introduction

Purchasing the most expensive camera system will not necessarily help to create better photographs. The user, with proper training, is the determining factor that can make a very expensive or an inexpensive camera perform well.

Photographers use many different cameras, devices, and tools to create amazing images. Dental photographers use much of the same equipment, in addition to various dentistry-specific tools, to create stunning photos. The following tips discuss some of the many items available to help assist practitioners in creating quality dental photographs and better dentistry.

> **“The user…is the determining factor that can make a very expensive or an inexpensive camera perform well.”**

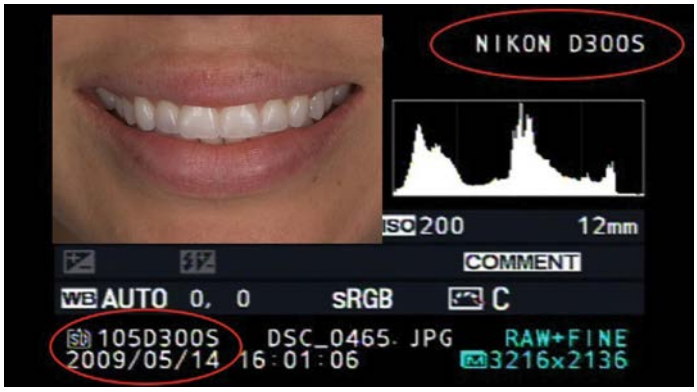
tip 1

A large preview liquid crystal display (LCD) screen on the back of the camera simplifies the process by enabling instant visualization of the image for verification of proper positioning, focus, and illumination. This is a valuable component to ensure that you capture the perfect image; if you haven’t, you can immediately recognize the mistake and take additional images to correctly capture the best image.

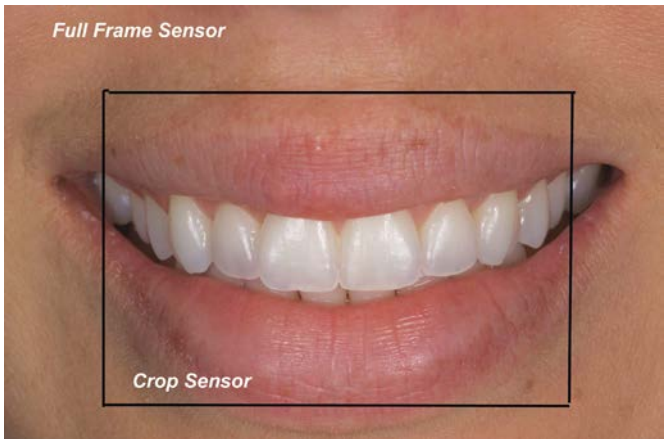
The LCD screen can be set up to show the recently taken image for evaluation, or it can be modified to allow additional information to be shown.

tip 2

The histogram setting on the camera is another valuable tool for instant evaluation of the exposure characteristics of the images taken. This allows for more fine-tuning of the camera settings for exposure, flash, and lighting. This important information ensures that the exposure settings were correct; and if they weren't, corrections can be made prior to moving on to the next photograph.



The histogram setting shown, which provides important information regarding the overall exposure of the image, can be utilized after capturing an image or by programming it to automatically appear after capturing an image.



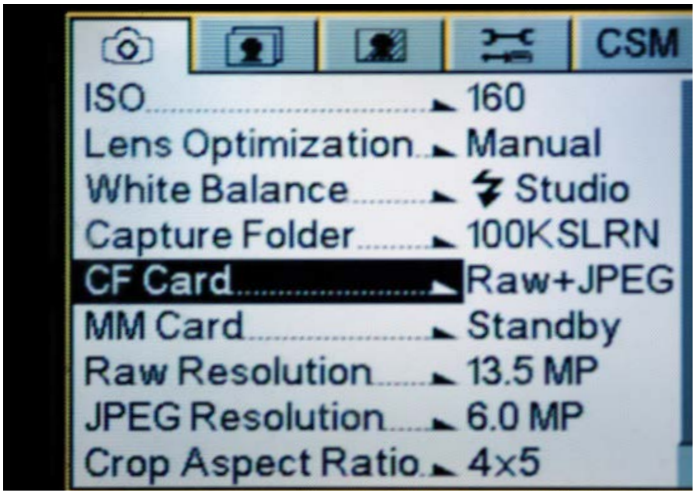
Example of an image taken with a full-frame sensor.

tip 3

A full-frame sensor allows for improved image quality and true 1:1 life-size images. Typically, a camera with a larger sensor costs more, but it provides better image quality in reproduction. When you are aiming for a specific magnification ratio, a full-frame sensor allows for more exact usage of the magnification ratios shown on lens housings compared to a crop camera sensor, which forces the user to back off magnification ratios to achieve the same magnification effect.

tip 4

A dual-output JPEG and RAW setting allows for original legal documentation but also provides a converted JPEG file for immediate use without having to create the file manually. The ability to utilize the RAW file to create other image file types in the future and maintain the original unaltered data, as well as the utilization process of a JPEG image, is very desirable.



The instant creation of two file types saves time and allows for legal documentation.

An Eye-Fi WiFi SD card works in most modern digital cameras and comes in various storage sizes and speeds.

tip 5

Having a WiFi SD card (Eye-Fi; Mountain View, CA) in your camera allows for the instant transfer of images or video via a wireless network to your computer server, saving precious time compared to traditional card readers or cables. Transferring data regularly from this card also ensures that you will always have enough available memory in the camera. These convenient cards save time, allowing you to be more productive.

tip 6

Using rechargeable batteries in your digital camera is significantly more cost-effective than relying on disposable batteries. This practice is also more environmentally friendly and convenient; you can recharge the batteries on site when needed instead of running out and having to purchase disposable batteries. The online price for a charger kit with eight batteries is typically only four times the cost of a two-pack of disposables—an expense that can be recouped very quickly.

Using rechargeable batteries can reap significant cost savings versus traditional disposable batteries.

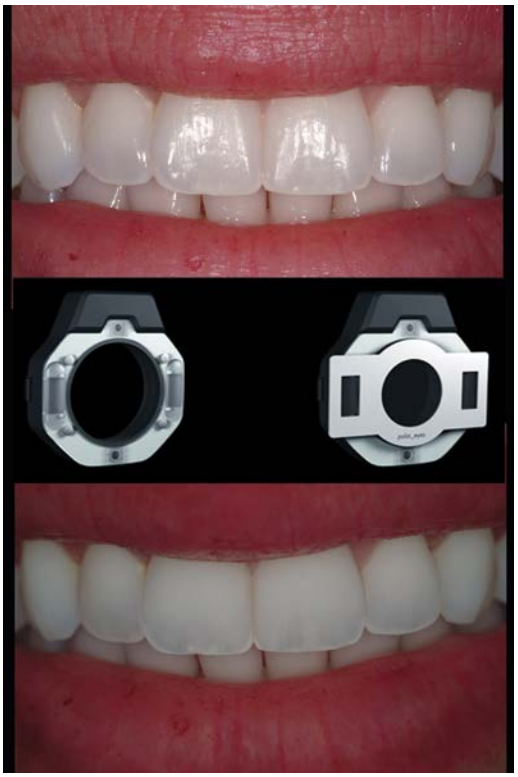
Metz MS-1 is a wireless flash stand-alone product that can attach to a lens and offers the traditional ring/dual-light combination for many camera systems.

tip 7

A wireless flash is a convenient and recommended accessory. Metz (Metz-Werke GmbH & Co. KG; Zirndorf, Germany) makes wireless flashes that are compact, lighter, and easier to manage than traditional flashes mounted on the camera.

tip 8

Polar_eyes (Photomed Int'l.; Van Nuys, CA) is a visualization and communication tool that can help the dentist and laboratory technician to better evaluate tooth shades, making color matching for direct and indirect restorations easier. By using polarizing filters over the lens and flashes in a quickly connecting system (via tiny magnets), it offers speed and convenience. Polar_eyes has different shapes to connect to virtually any dental ring flash system. This device removes spectral flash from the teeth, allowing for better color evaluation.



This example of an anterior 1:2 image highlights how useful the color evaluation can be when using polar_eyes compared to a standard flash system. Notice how much better the visualization becomes when evaluating the incisal characteristics and color.

Two Nikon SB R200 external flashes positioned on the lens housing.

tip 9

The Nikon SB R200 external flash (Nikon Corp.; Melville, NY) is available in lightweight cordless and wireless versions that can be easily positioned on the lens or on different brackets for more versatility, compared to a traditional combination ring flash. It can also be used as an individual "slave light" for portrait photography. The convenience of affixing flashes in many different positions is desirable when taking portraits and intraoral/extraoral photographs.

tip 10

Canon 270EX II wireless flashes (Canon Inc., Melville, NY) can be attached to an R2 bracket for more convenient flash positioning. Additionally, they can be taken off the bracket and used as a "slave light" for portrait photography.

Canon 270EX II wireless flashes attached to R2 brackets provide versatility in flash positioning for any lighting needs.

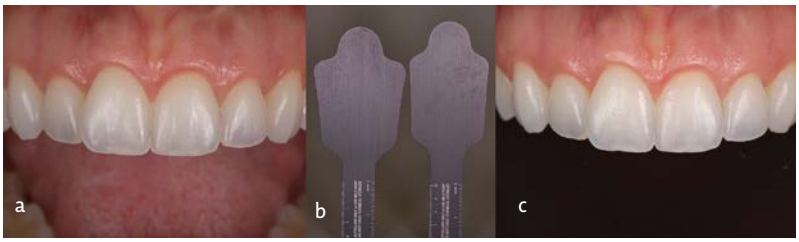
The R2 bracket can be positioned close to the lens for intraoral photography. Within seconds, the flashes can be repositioned by moving the bracket arms to take extraoral and portrait images.

tip 11

The R2 bracket is a versatile bracket for individual flashes. It utilizes a standard camera mount thread screw to attach to the base of most cameras and allows for immediate repositioning of external flashes from either very close to the lens (for intraoral illumination), or moving more than a foot away from the lens (for extraoral illumination and portrait use).

tip 12

Intraoral contrasters (PhotoMed Int'l.) are most often created from anodized handheld metal devices that can be used to enhance photographs by blocking out various tissues that distract the eye. This makes final images look like they were shot by a professional. Contrasters come in many different sizes and shapes for masking the oral pharynx, tongue, lips, and nose to create more pleasing images. Flexipallette (Smile Line, in partnership with Styleitaliano; Saint-Imier, Switzerland) offers another line of unique contrasters that have the same function and appearance as the anodized metal variety, but are unique in that they are the only flexible type available and are softer to the touch.



The use of intraoral contrasters can instantly enhance the overall image, making it look more professional by blocking out distracting teeth and tissues. Notice how an image (a), after using a contraster (b), looks more professional (c).

tip 13

TS Retractors (TCS Aesthetics; Laguna Niguel, CA) are simple, small devices that allow for easier positioning of the lips when taking intraoral 1:1 photographs with intraoral contrasters or when capturing images with various intraoral mirrors. These retractors allow patients to open wider because they do not bind as much of the tissues during opening.

Standard retractors do not allow the patient to open as wide, produce a limited space in which to work, and create more tension on the lips.

tip 14

Standard universal short, plastic, double-ended retractors are still mandatory for 1:2 retracted anterior images. They provide two convenient and quick size options for different mouth sizes and can be fabricated from metal or plastic. They save time and the expense of not having to own or locate a different-sized set of retractors when taking intraoral photographs that require retractors.

Whether the patient has an average-size or small mouth, or limited opening, the same retractor can be used by simply using the opposite end of the retractor.

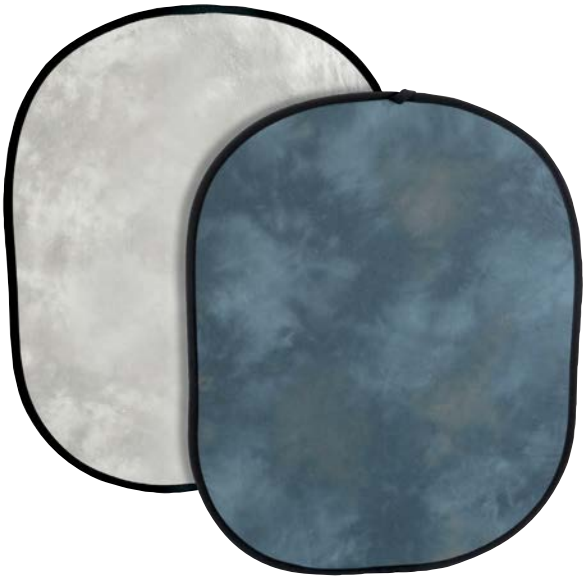
Examples of different flash diffusers from Opteka (SB-1, FB-50, FS-80).

tip 15

Flash diffusers offer an inexpensive means to create portrait-style images when space or finances are limited. Several companies make similar products. **The image to the left** shows examples from Opteka. LumiQuest also offers three similar styles (mini soft box, pocket bouncer, and 80-20); as does Zeikos (ZE-SBD, Zeikos Universal Professional Pocket Digital Camera Flash Bouncer, and ZE-SD26).

tip 16

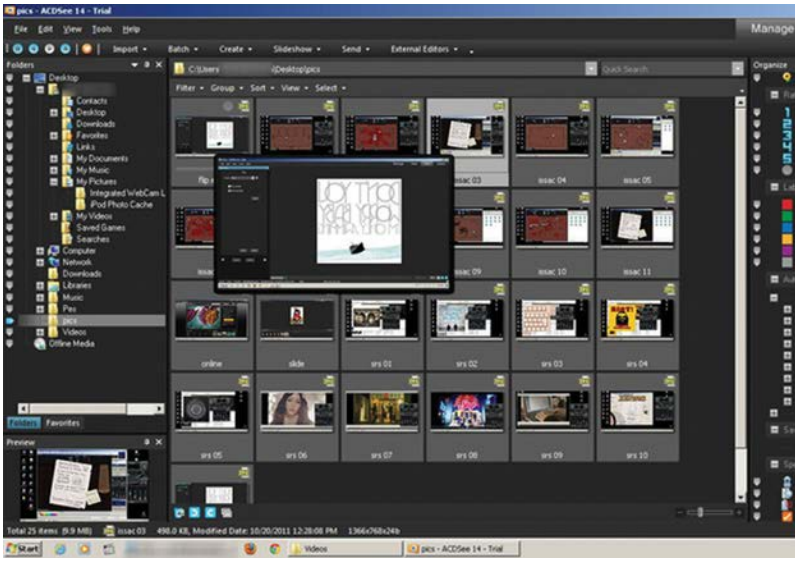
A double-sided (with a dark color on one side and light color on the other), portable, and collapsible muslin cloth backdrop is a relatively inexpensive accessory that can be taken anywhere and set up conveniently for portrait studio photography, even in confined areas.



Collapsible, double-sided, and portable muslin backdrops are versatile and provide two color options in a single item.

tip 17

Digital image management software offers users the ability to categorize and title each image and create searchable tag words for easier image archiving and retrieval. Each image can be tagged with valuable information, including specific procedural term, type of cement or bonding agent, ceramic, and date completed. These applications can range in price from free to several hundred dollars, with excellent programs available for less than $100. Recommended products include Adobe Lightroom 4 (Adobe Systems; San Jose, CA); ACDSee 15 (ACD Systems; Seattle, WA); Photoshop Elements 11 (Adobe Systems); and Google Picasa (Google; Mountain View, CA). Each of these products offers various levels of image retrievability based upon tags created by the user.



Digital image management software can simplify the process of storing and retrieving large image databases. Pictured is a screenshot of ACDSee 14.

A basic collapsible reflector, available in different colors, can help direct more lighting toward the face when taking portraits.

tip 18

A basic collapsible reflector can be used with a backdrop or color wall virtually anywhere within an office and with minimal space requirements. Reflectors help to add more light from one or more existing sources to various areas of the face, resulting in less need for additional lighting.

Summary

Mastering dental photography techniques is just one important step in capturing and documenting a case. The tips presented in this article are just a few of many that can help to enhance our skills and the quality of our photographic documentation.

Acknowledgment

The author thanks the various manufacturers for the use of their images.

Dr. Snyder is an Accredited Member of the AACD. He practices in Laguna Niguel, California.

Disclosure: The author is a stock shareholder in TCS Aesthetics.

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Demystifying the Digital Dental Photography Workflow

The Big Picture: Facial Documentation with High Visual Impact Photography

Panos Bazos, DDS
Michel Magne, MDT, BS

Abstract

With patients demanding a higher standard of excellence in all realms of dental practice, clinicians and technicians must evolve accordingly in multiple disciplines, particularly in digital imaging so as to improve visual communication. Without doubt, the advent of digital photography and computer technology has revolutionized the way we work, think, and act in daily practice. The purpose of this article is to offer a standardized protocol that will provide the necessary photographic images to initiate facial analysis.

Key Words: photographic documentation, facial analysis, digital photography

Introduction

In order for an esthetic and functional rehabilitation to be initiated, properly exposed facial images must be obtained to convey the information required for a proper diagnosis, leading to a successfully sequenced treatment plan. These images will form the foundation for preliminary multidisciplinary communication, saving the whole restorative team and the patient significant time and expense.

While facial analysis aims to assess possible frontal and sagittal plane asymmetries, additional pertinent details that can be gained are tooth form and position, relative tooth size and shape, and the amount of gingival display at the various dynamic lip positions.

Choosing the Equipment

With the advent of digital single-lens reflex (DSLR) technology, camera bodies in the prosumer range (Nikon D7000 or D600; Melville, NY) are chosen because they can provide adequate resolution (16-24 megapixels), while having the ability to be paired with a variety of lenses, whether it be fixed (105mm or 60mm) or variable (18-200mm) focal length. In addition, there is an illumination system with strobes that can be radio-controlled wirelessly from a transmitter (PocketWizard, LPA Design; South Burlington, VT) on the camera; or the Nikon Creative Light System (CLS), which is wirelessly controlled via infrared.

Choosing the Background

A white background is the optimal choice because it provides neutrality and maximizes contrast with the subject. This pristine lightness and brightness often imparts a sensation of freshness, cleanliness, and youthfulness. It is the ideal color choice because it conveys purity and simplicity, simultaneously creating a sense of openness.

1: Warm or high-contrast image.

Subject: The Center of Attention

The subject ideally should be upright in a relaxed, natural position, preferably with the hair drawn back to allow for symmetric illumination of the face. Soft makeup application is acceptable with a preference toward neutral tones. For more advanced photography a gold reflector may be used to warm up the flesh tones, while a silver reflector may be used to increase specular highlights, yielding a high-contrast image **(Fig 1)**.

> “These images will form the foundation for preliminary multidisciplinary communication.”

Frontlighting: Illuminating the Subject

The primary goal is to evenly illuminate the subject and obtain a proper exposure. The height of the strobes is set according to the height of the subject. Two strobes with attached softbox diffusers are positioned equidistant in front of the subject, ensuring a smooth and even distribution of diffuse light, rendering a soft illumination **(Figs 2-4)**. To consistently obtain a proper exposure, an incident light meter can be used. Taking an incident-light reading requires placing the meter at the subject’s position and pointing it in the general direction of the camera, simulating the photoshoot and testing the flash output until the desired exposure measurement is obtained. This process facilitates the initial light calibration and ensures a proper exposure of the subject, eliminating the random trial-and-error process.

Backlighting: Illuminating the Background

The primary goal is to evenly illuminate the background. The height of the strobes is set according to the height of the subject. Two strobes are positioned behind the subject, at a 45-degree angle equidistant toward the surface of the wall to ensure a smooth distribution of the light. When using a white background it is critical not to over-illuminate. This is because the background will act as a reflector, bouncing a significant amount of light back toward the camera and onto the back of the subject, overexposing the details of the subject to such an extent that it would obliterate all the fine-edge definition. Lens flaring would also result in a desaturated image capture. By using an incident light meter for the initial calibration, the aim is to make every part of the background measured within +1 stop. This creates a perfectly even illuminated background **(Figs 2-4)**.

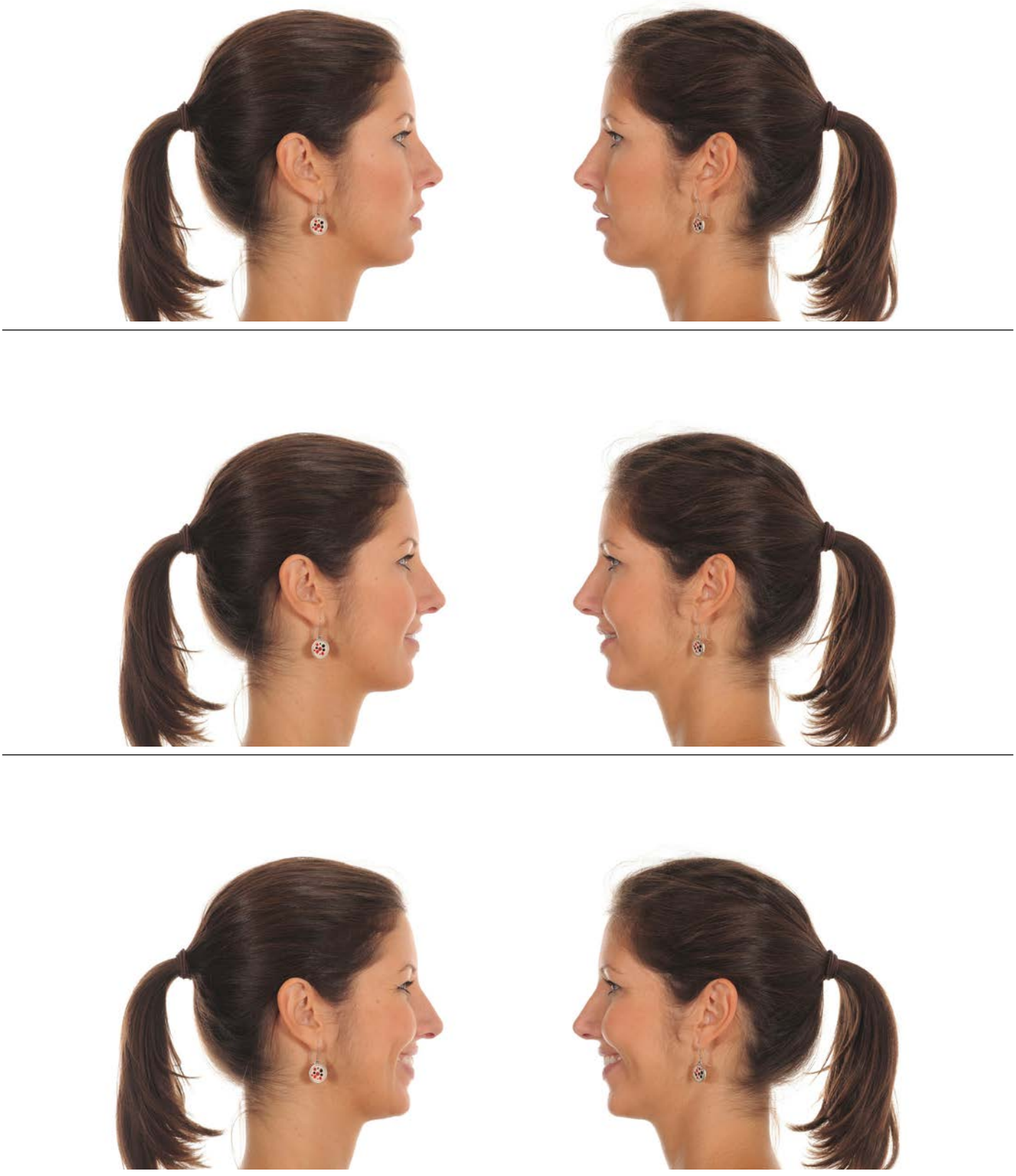
Figure 2 shows two strobes illuminating the subject (frontlighting) and the other two strobes illuminating the white wall. This, in turn, reflects off the white wall to provide a backlit illumination.

2: Lighting calibration.

3: Softbox Illumination.

4: Photographer's POV.

5: Frontal and oblique views.



6: Sagittal views.

> “Proportion and symmetry in conjunction with harmony and balance are the cornerstones of a satisfying smile.”

Focusing on the Eyes

When using a telephoto lens, the depth of field tends to be shallow. It therefore is critical to focus on the subject's eyes, maximizing sharpness and detail, attaining high visual impact. (The human eye, after all, is drawn to the human eye.) Even though most autofocus features work exceptionally well, it is good practice to know how to use the camera's manual functions. Using manual focus also ensures consistent focusing.

The Photographic Facial Sequence

Each sequence requires capturing the three degrees of smile (repose, e-position, and full smile) and must be done swiftly, giving the subject the opportunity to maintain a stable postural position throughout the photoshoot. To obtain objective information for the facial analysis with regard to the frontal (0 degrees), oblique (45 degrees), and sagittal (90 degrees) views at various dynamic lip positions, 15 images are required **(Figs 5 & 6)**.

Conclusion

A systematic approach to photographic documentation will lead to predictable and repeatable results. Proportion and symmetry in conjunction with harmony and balance are the cornerstones of a satisfying smile. These images will serve as the foundation for successful data collection and communication among the restorative team. **jCD**

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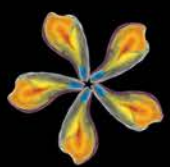

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April 27, 2013

What's In My CAMERA

Esteemed Educators Share Their Favorite Photography Items

AS DENTAL PROFESSIONALS AND AVID PHOTOGRAPHERS, WE LOVE TO KNOW WHAT OTHERS FIND USEFUL WHEN IT COMES TO CAMERAS. NOT TO MENTION, WE LOVE THE FUN ACCESSORIES THAT CAN HELP BRING OUT THE BEST IN OUR PHOTOGRAPHY. HERE, FIVE DIFFERENT DENTAL EDUCATORS SHARE WITH US SOME OF THEIR FAVORITE ITEMS AND TIPS.

THE QUESTIONS:

1. What is the name and brand of the camera body you use for dental photography?
2. What is your preferred flash for shooting teeth?
3. What is your favorite accessory for shooting teeth?
4. What is the most indispensable item in your photography toolbox?
5. Other than teeth, what do you enjoy photographing the most?
6. Can you provide one tip that you found helpful when shooting either clinical images or images for enjoyment?

BAG?

EDWARD A. MCLAREN, DDS
Los Angeles, CA

1. I use the Nikon D800E, but I recommend the Nikon D7000, because of the two user settings that make the camera user friendly and easy to train staff.
2. Nikon R1C1 with the PhotoMed dual point bracket.
3. Linear polarizers for the 2 Nikon flashes.
4. Flash with bracket (R 200 [R1C1 system] with PhotoMed bracket).
5. Portraits and full body shots.
6. For teeth—use a 2 point flash system—put linear polarizers on the flashes—this will knock down 30% of the glare—set the flashes 3 inches away from the lens and slightly behind the lens—shoot images for shade communication in RAW file format.

OLIVER BRIX, MDT
Kelkheim, Germany

1. My personal camera is a Nikon D700 body full frame with a 105 Macro lens.
2. Twin Flash Nikon R1C1.
3. LumiQuest Pocket Bouncers for absolute soft lighting.
4. polar_eyes filter/cross-polarizer.
5. Beaches at sunrise and sundown.
6. Understanding photography is painting with light. Try to imagine the illumination similar to daylight conditions.

DARIO ADOLFI, DDS
Sao Paulo, Brazil

1. Canon EOS 7D.
2. Canon MacroTwin Lite MT-24EX.
3. Canon Speedlite 270EX II.
4. A lip retractor for intraoral photography.
5. Beautiful landscape photos.
6. a. For clinical photography images using black background is very helpful; cut the lip retractor, removing one of the wings for small and limited mouth opening.
   b. For photography frontal view, both wings from the lip's retractor size should be reduced for a very small mouth.

PANOS BAZOS, DDS
Athens, Greece

1. I have recently upgraded to the Nikon D800E, which also provides HD video capabilities and is equipped with a 36.3MP FX-format CMOS sensor. This camera body is paired with a Nikon 60mm f/2.8 Micro-NIKKOR AF-D lens, when photographing the anteriors; or a Nikon 105mm f/2.8 Micro-NIKKOR AF-D lens, when photographing the posteriors. My favorite camera body remains the Nikon D200, equipped with a 10.2MP FX-format CCD sensor.
2. The Nikon R1C1 Wireless Close-Up Speedlight System, which features Two SB-R200 Wireless Remote Speedlights with the SU-800 Wireless Speedlight Commander.
3. The polar_eyes filter, which I designed, which allows for a glare-free image, making it ideal for shade estimation.
4. My customized Novoflex XX Halter bracket with the RRS L-plate and quick disconnect.
5. Panoramic landscapes and long exposure architectural photography.
6. Capturing digital photos in RAW mode in conjunction with the use of a Whibal Card provides a variety of benefits, such as the ability to fine-tune color temperature after image capture, standardize luminosity values, allow for greater exposure latitude than JPEG capture, and impart the opportunity to work with high-bit data.

NEWTON FAHL, JR., DDS, MS
Curitiba, Brazil

1. Canon 5D Mark II—A pro camera that speaks for itself. The TV show *House* was completely filmed with it. True colors for dentistry.
2. Canon MT-24EX Macro Twin Lite Flash with a PhotoMed R2 Dual Point Flash Bracket. This combination is dynamite for getting the best angles, allowing me to produce shadows where needed. Great depth and anatomy reproduction.
3. Black and grey contrasters. The black is great for capturing the depth and translucency of the incisal edges and the neutral grey is fantastic for shade selection and color perception overall.
4. Having the proper lenses for the right occasion really is essential. A Canon MP-E 65 mm Macro lens is one of them.
5. My wife, Grace, and my two golden retrievers, Kin and Dolly.
6. Shooting on a Manual mode allows for custom shots better than any other setting. Having an 18% neutral grey card handy proves very helpful to achieve custom white balance for each lighting condition.

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Smile Analysis

The Photoshop® Smile Design Technique: Part I

Edward A. McLaren, DDS
Lee Culp, CDT, AAACD

Abstract

Computer design software will become the main communication technology between dentists and ceramists and a useful tool for showing patients the possibilities for enhancing their smiles. Despite the modern age of smile design, which enables the use of technology to create and design an ideal smile, ceramists involved with the fabrication process still rely on sound concepts and principles of facial and dentofacial esthetics. By understanding the elements of esthetics and learning how to incorporate technology applications into clinical dentistry, clinicians can predictably plan smile design cases and communicate anticipated results to patients and ceramists alike. This article, the first in a two-part series, introduces elements of smile design and reviews some timeless concepts. It discusses new, step-by-step techniques for incorporating digital technology into the smile design process that can be accomplished in approximately three to four minutes. The second article will address tooth anatomy, morphology, and the various laboratory applications for digital design.

Key Words: esthetic dentistry, smile design, digital technology


The smile analysis/design process begins at the macro level, examining the patient's face first, progressing to an evaluation of the individual teeth, and finally moving to material selection considerations.

Introduction: Smile Analysis and Esthetic Design

Dental facial esthetics can be defined in three ways:

- Traditionally, dental and facial esthetics have been defined in terms of macro and micro elements. Macro esthetics encompasses the interrelationships between the face, lips, gingiva, and teeth and the perception that these relationships are pleasing. Micro esthetics involves the esthetics of an individual tooth and the perception that the color and form are pleasing.
- Historically, accepted smile design concepts and smile parameters help to design esthetic treatments. These specific measurements of form, color, and tooth/esthetic elements aid in transferring smile design information between the dentist, ceramist, and patient. However, esthetics in dentistry can encompass a broad area—known as "the esthetic zone."[1]
- Rufenacht delineated smile analysis into facial esthetics, dentofacial esthetics, and dental esthetics, encompassing the macro and micro elements described in the first definition above.[2] Further classification identifies five levels of esthetics: facial, oral-facial, oral, dentogingival, and dental **(Table 1)**.[1,3]

Initiating Smile Analysis: Evaluating Facial and Oral-Facial Esthetics

The smile analysis/design process begins at the macro level, examining the patient's face first, progressing to an evaluation of the individual teeth, and finally moving to material selection considerations. Multiple photographic views (e.g., facial, sagittal) facilitate this analysis.

At the macro level, facial elements are evaluated for form and balance, with an emphasis on how they may be affected by dental treatment.[3,4] During the macro analysis, the balance of the facial thirds is examined **(Fig 1)**. If something appears unbalanced in any one of those zones, the face and/or smile will appear unesthetic.

Table 1. Components of Smile Analysis and Esthetic Design.

Levels of Esthetics	Smile Analysis Components
Facial esthetics	total facial form and balance
Oral-facial esthetics	maxillo-mandibular relationship to the face and the dental midline to the face pertaining to the teeth, mouth, gums
Oral esthetics	labio, dento, gingival; the relationships of the lips to the arches, gingiva, and teeth
Dentogingival esthetics	the relationship of the gingiva to the teeth collectively and individually
Dental esthetics	macro and micro dental esthetics, both inter- and intra-tooth

Such evaluations help determine the extent and type of treatment necessary to affect the esthetic changes desired. Depending on the complexity and uniqueness of a given case, orthodontics could be considered when restorative treatments alone would not produce the desired results **(Fig 2)**, such as when facial height is an issue and the lower third is affected. In other cases—but not all—restorative treatments could alter the vertical dimension of occlusion to open the bite and enhance esthetics when a patient presents with relatively even facial thirds **(Fig 3)**.

Evaluating Oral Esthetics

The dentolabial gingival relationship, which is considered oral esthetics, has traditionally been where treatment planning is initiated. This process begins by determining ideal maxillary incisal edge placement **(Fig 4)**. This is accomplished by understanding the incisal edge position relative to several different landmarks. The following are questions to determine ideal incisal edge position:

- Where in the face should the maxillary incisal edges be placed?
- What is the proper tooth display, both statically and dynamically?
- What is the proper intra- and inter-tooth relationship (e.g., length and size of teeth, arch form)?
- Can the ideal position be achieved with restorative dentistry alone, or is orthodontics needed?

To facilitate evaluating smiles based on these landmarks, the rule of 42.2—which refers to the amount of maxillary central display when the lips are at rest, the amount of gingival tissue revealed, and the proximity of the incisal line to the lower lip—is helpful **(Figs 5a & 5b)**. At a time when patients perceive fuller and brighter smiles as most esthetic, 4 mm of maxillary central incisor display while the lips are at rest may be ideal.[2,5] In an esthetic smile, seeing no more than 2 mm of gingiva when the patient is fully smiling is ideal.[6] Finally, the incisal line comes very close to and almost touches the lower lip, being no more than 2 mm away.[2] These guidelines are somewhat subjective and should be used as a starting point for determining proper incisal edge position.

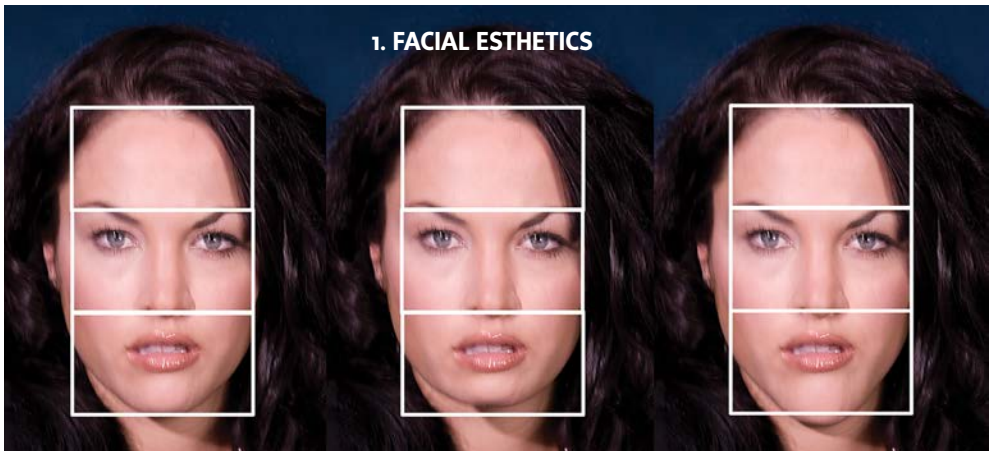


Figure 1: Three altered views of the same patient enable analysis of what can be accomplished to enhance facial and smile esthetics.

Figure 2: Sagittal views best demonstrate which specialists should be involved in treatment, whether orthodontists or maxillofacial surgeons, to best esthetically alter the facial esthetics.

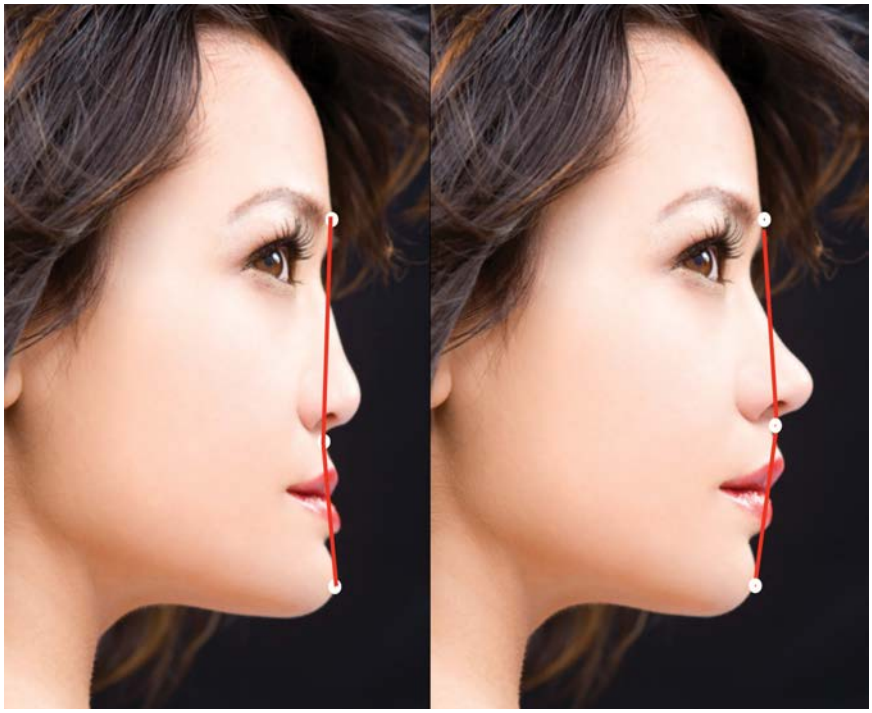
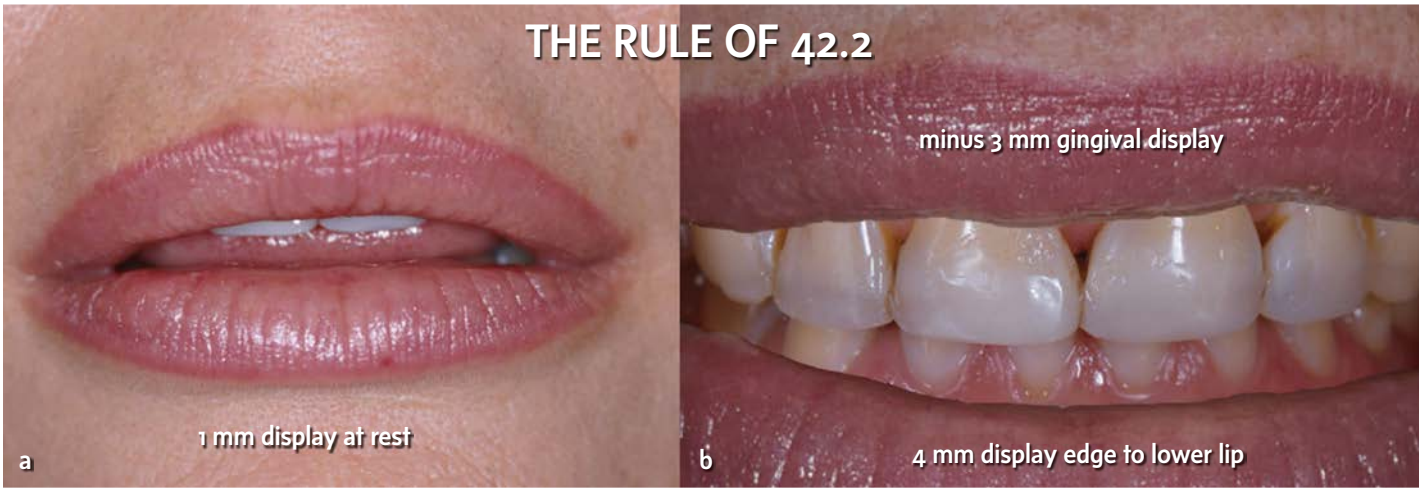


Figure 3: Drawing a line on the glabella, subnasale, and pogonion enables a fast evaluation of esthetics without the need for radiographs to determine alignment of ideal facial elements.

Figure 4: Evaluating the maxillary incisal edge position is the starting point for establishing oral esthetics.



Figures 5a & 5b: According to the 42.2 rule, this patient's smile is deficient in esthetic elements, having only 1 mm of tooth display at rest (a), 4 mm of space between the incisal edge and the lower lip (b), and minus 3 mm gingival display (b).

Dentogingival Esthetics

Gingival margin placement—and the scalloped shape, in particular—are well discussed in the literature. As gingival heights are measured, heights relative to the central, lateral, and canine in an up/down/up relationship are considered esthetic **(Fig 6)**. However, this may create a false perception that the lateral gingival line is incisal to the central incisor. Rather, in the most esthetic tooth relationships, the gingival line of the four incisors is approximately the same line **(Fig 6)**, with the lateral perhaps being slightly incisal.[7] The gingival line should be relatively parallel to the horizon for the centrals and the laterals and symmetric on each side of the midline.[2,8] The gingival contours (i.e., gingival scallop) should follow a radiating arch similar to the incisal line. The gingival scallop shapes the teeth and should be between 4 to 5 mm **(Fig 7)**.[9]

Figure 6: Gingival symmetry in relation to the centrals, laterals, and canines is essential to esthetics. Optimal esthetics is achieved when the gingival line is relatively horizontal and symmetrical on both sides of the midline, when considering the centrals and laterals.

Related to normal gingival form is midline placement. Although usually the first issue addressed in smile design, it is not as significant as tooth form, gingival form, tooth shape, or smile line. Several rules can be applied when considering modifying the midline to create an esthetic smile design.

- The midline only should be moved to establish an esthetic intra- and inter-tooth relationship, with the two central incisors being most important.
- The midline only should be moved restoratively up to the root of the adjacent tooth.
- If the midline is within 4 mm of the center of the face, it will be esthetically pleasing.
- The midline should be vertical when the head is in the postural rest position.

Evaluating Dental Esthetics

Part of evaluating dental esthetics for smile design is choosing tooth shapes for patients based on their facial characteristics (e.g., long and dolichocephalic, or squarish and brachiocephalic). When patients present with a longer face, a more rectangular tooth within the esthetic range is appropriate. For someone with a square face, a tooth with an 80% width-to-length ratio would be more appropriate. The width-to-length ratio most often discussed in the literature is between 75 and 80%, but esthetic smiles could demonstrate ratios between 70 and 75% or 80 to 85% **(Figs 8-10)**.[1]

The length of teeth also affects esthetics. Maxillary central incisors average between 10 to 11 mm in length. According to Magne, the average length of an unworn maxillary central to the cemento-enamel junction is slightly over 11 mm.[10] The esthetic zone for central incisor length, according to the authors, is between 10.5 and 12 mm, with 11 mm being a good starting point. Lateral incisors are between 1 mm to a maximum of 2.5 mm shorter than the central, with the canines slightly shorter than the central by between 0.5 to 1 mm **(Fig 11)**.

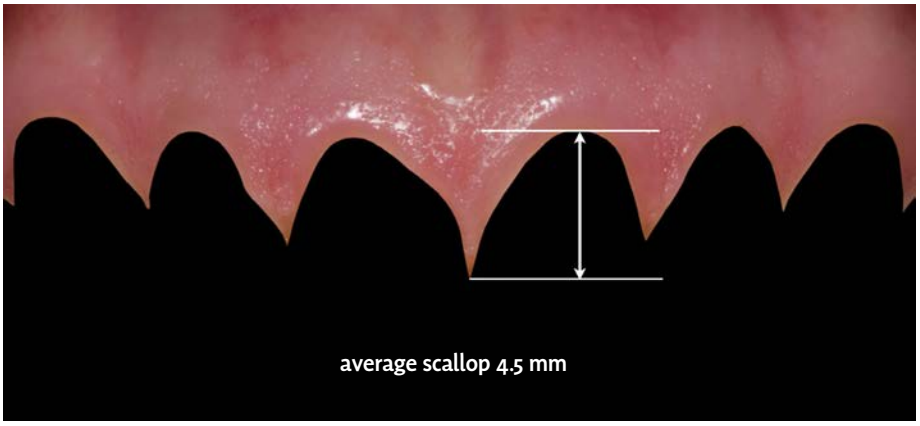


Figure 7: The esthetic ideal from the gingival scallop to the tip of the papilla is 4 to 5 mm.

Figures 8-10: Acceptable width-to-length aspect ratios fall between 70 to 85%, with the ideal range between 80 to 85%.

The inter-tooth relationship, or arch form, involves the golden proportion and position of tooth width. Although it is a good beginning, it does not reflect natural tooth proportions. Natural portions demonstrate a lateral incisor between 60 to 70% of the width of the central incisor, which is larger than the golden proportion.[11] However, a rule guiding proportions is that the canine and all teeth distal should be perceived to occupy less visual space **(Fig 12)**. Another rule to help maintain proportions throughout the arch is 1-2-3-4-5; the lateral is 2/3 of the central and the canine is 4/5 of the lateral, with some latitude within those spaces **(Fig 13)**. Finally, contact areas can be moved restoratively up to the root of the adjacent tooth. Beyond that, orthodontics is required **(Fig 14)**.

Creating a Digital Smile Designed in Photoshop

Although there are digital smile design services available to dentists for a fee, it is possible to use Photoshop CS5 software (Adobe Systems; San Jose, CA) to create and demonstrate for patients the proposed smile design treatments. It starts by creating "tooth grids"—predesigned tooth templates in different width-to-length ratios (e.g., 75% central, 80% central) that can be incorporated into a custom smile design based on patient characteristics. You can create as many different "tooth grids" as you like with different tooth proportions in the esthetic zone. Once completed, you will not have to do this step again, since you will save the created tooth grids and use them to "stamp" in a new desired outline form of the desired teeth. Follow these recommended steps:

1. To begin creating a "tooth grid," use a cheeks-retracted image of an attractive smile as a basis (e.g., one with a 75% width-to-length ratio). Open the image in Photoshop and create a new clear transparent layer on top of the teeth **(Fig 15)**. This transparent layer will enable the image to be outlined without the work being embedded into the image.
2. Name the layer appropriately and, when prompted to identify your choice of fill, choose "no fill," since the layer

Figure 11: An acceptable starting point for central incisors is 11 mm in length, with lateral incisors 1 to 2.5 mm shorter than the centrals, and canines 0.5 to 1 mm shorter than the centrals for an esthetic smile display.

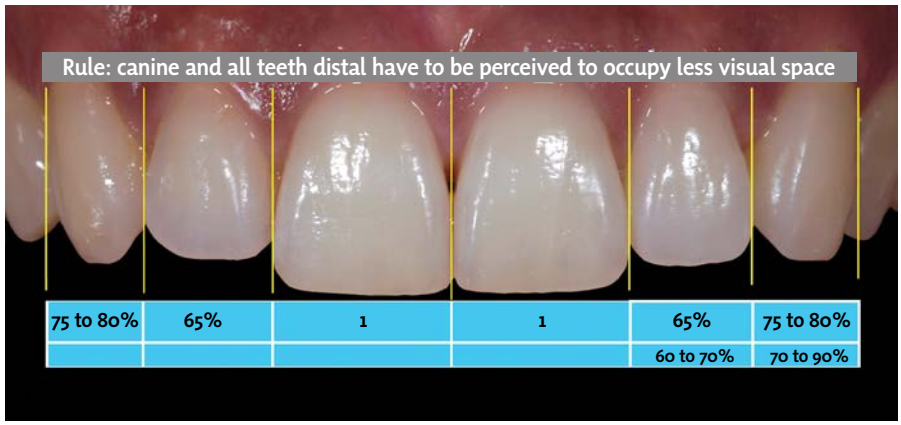


Figure 12: The canines and other teeth distally located are visually perceived as occupying less space in an esthetically pleasing smile.

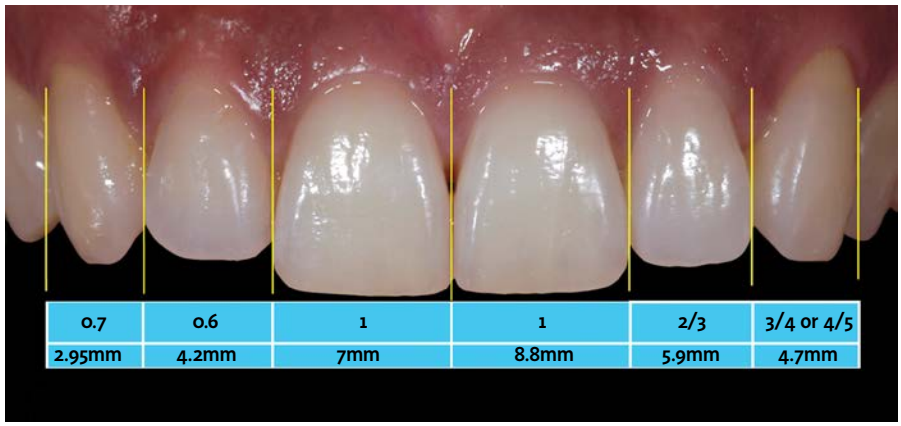


Figure 13: A general rule for achieving proportionate smile design is that laterals should measure 2/3 of the centrals and canines 4/5 of the laterals.

will be transparent, except for the tracing of the "tooth grid."

3. To begin tracing the tooth grid, activate a selection tool, move to the tool palette, and select either the polygon lasso tool or the magnetic lasso tool. In the authors' opinion, the polygon works best. Once activated, zoom in **(Fig 16)** and trace the teeth with the lasso tool.
4. To create a pencil outline of the tooth, with the transparent layer active, click on the edit menu in the top row; in the edit drop-down menu, select "stroke"; choose black for color, and select a 2-pixel stroke pencil line **(Fig 17)**, which will create a perfect tracing of your selection. Click "OK" to stroke the selection. Select (trace with the lasso selection tool) one tooth at a time and then "stroke" it **(Fig 18)**. Select and stroke (trace) the teeth up to the second bicuspid (the first molar is acceptable) **(Fig 19)**.
5. The image should be sized now for easy future use in a smile design. In the authors' experience, it is best to adjust the size of the image to a height of 720 pixels **(Fig 20)** by opening up the image size menu and choosing 720 pixels for the height. The width will adjust proportionately.
6. At this time, the "tooth grid" tracing can be saved, without the image of the teeth, by double-clicking on the layer of the tooth image. A dialog box will read "new layer"; click "OK." This process "unlocks" the layer of the teeth so it can be removed. Drag the layer of the teeth to the trash, leaving only the layer with the tracing of the teeth **(Fig 21)**. In the file menu, click "save as" and choose ".png" or ".psd" (Photoshop) as the file type. This will preserve the transparency. You do not want to save it as a JPEG, since this would put a white background around the tracing. Name the file appropriately (e.g., 75% W/L central).
7. By tracing several patients' teeth that have tooth size and proportion "in the esthetic zone" and saving them, you can create a library of tooth grids to custom design new teeth for your patients who require smile designs.

Digital dentistry is enabling dentists to provide what patients demand: quick, comfortable, and predictable dental restorations that satisfy their esthetic needs.

Figure 14: If feasible, the contact areas can be restoratively moved up to the root of the adjacent tooth.

Figure 15: Photoshop provides an effective and inexpensive way to design a digital smile with proper patient input. To start creating "custom tooth grids," open an image of an attractive smile in Photoshop and create a separate transparent layer.

Figure 16: The polygon lasso tool is an effective way to select the teeth.

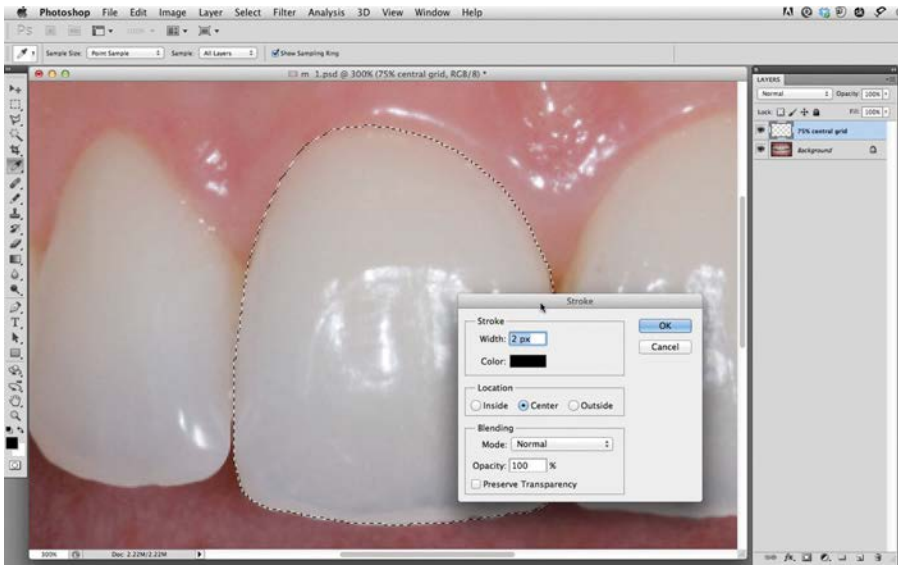


Figure 17: Go to edit>stroke, then use a 2-pixel stroke line (with color set to black) to trace your selection. Make sure the transparent layer is the active working layer.

The Photoshop Smile Design (PSD) Technique

The PSD technique can be done on any image, and images can be combined to show the full face or the lower third with lips-on and lips-off view. This article **(Part 1)** addresses how to do it on the cheeks-retracted view. Part 2 of this article will review more possibilities using the technique.

The first step in the PSD technique is to create an actual tooth length to digital conversion, and then digitally determine the proposed new length and proportion of the teeth.

Determining Digital Tooth Size

To determine digital tooth size, follow these steps:

1. Create a conversion factor by dividing the proposed length (developed from the smile analysis) by the existing length of the tooth.
2. The patient's tooth can be measured in the mouth or on the cast **(Fig 22)**. If the length measures 8.5 mm but needs to be at 11 mm for an esthetic smile, divide 11 by 8.5. The conversion factor equals 1.29, a 29% digital increase lengthwise.
3. Open the full arch cheeks-retracted view in Photoshop, and zoom in on the central incisor.
4. Select the eyedropper palette. A new menu will appear. Select the ruler tool **(Fig 23)**.
5. Click and drag the ruler tool from the top to bottom of the tooth to generate a vertical number, in this case 170 pixels **(Fig 24)**. Multiply the number of pixels by the conversion factor. In this case, 170 x 1.29 = 219 pixels; 219 pixels is digitally equivalent to 11 mm **(Fig 25)**.
6. Determine the digital tooth width using the same formula.
7. Create a new layer, leave it transparent, and mark the measurement with the pencil tool **(Fig 26)**.

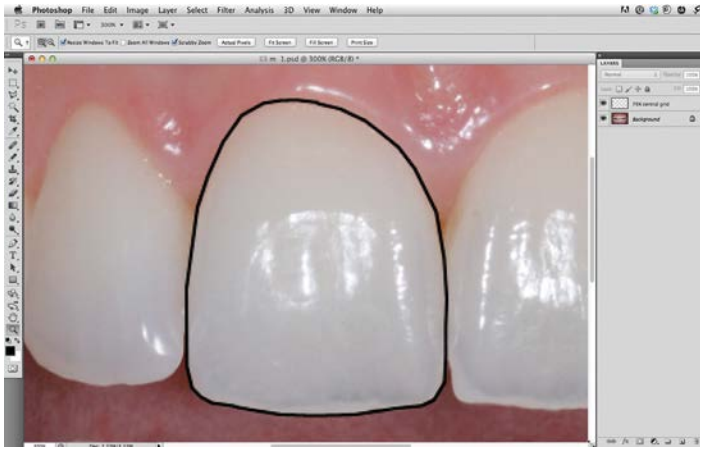


Figure 18: Image of the central with a 2-pixel black stroke (tracing).

Figure 19: Image of the teeth traced up to the second bicuspid to create a tooth grid.

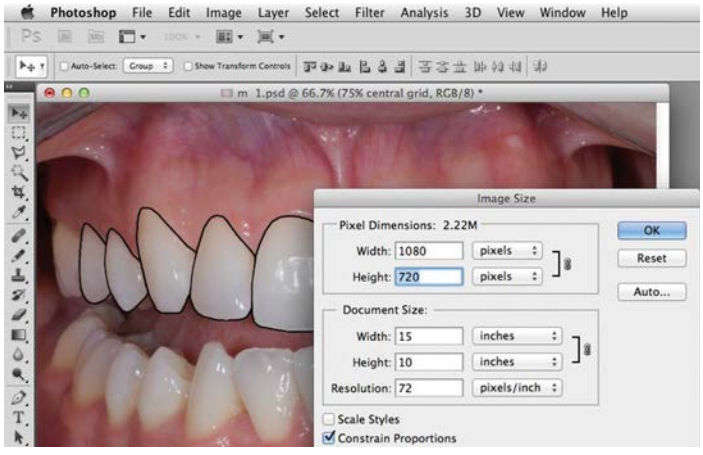


Figure 20: Size the image in Photoshop.

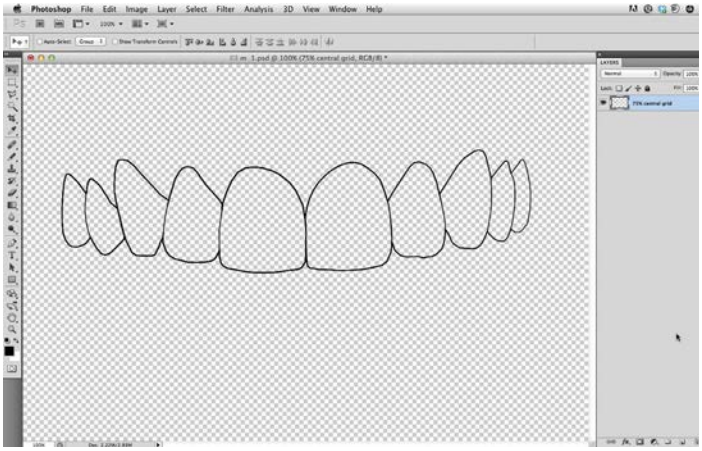


Figure 21: Save the grid as a .png or .psd file type and name it appropriately. Create other dimension grids using the same technique.

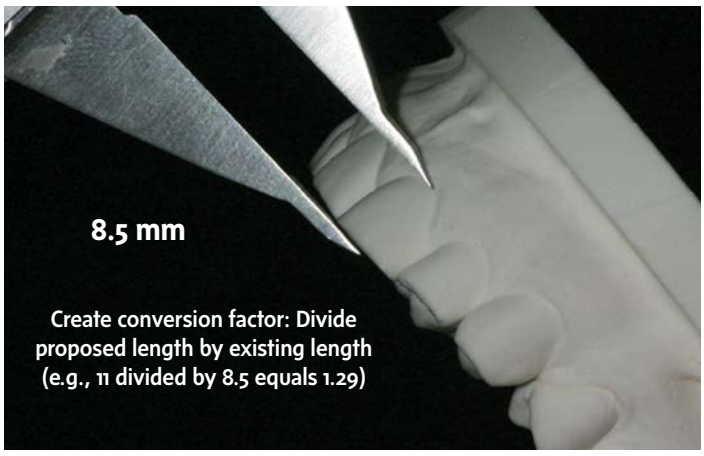


Figure 22: To determine the digital tooth size, a conversion factor is created by dividing the proposed length by the existing length of the tooth.

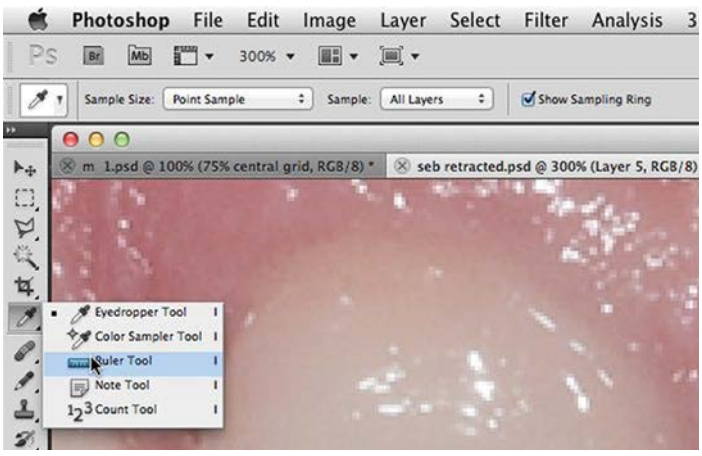


Figure 23: Select the ruler tool in Photoshop.

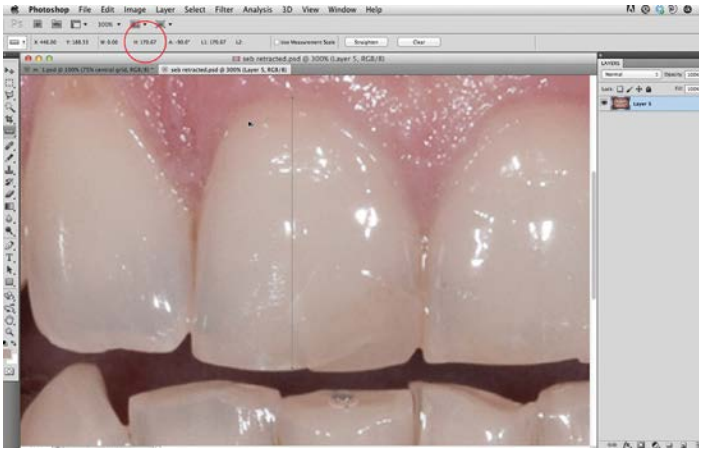


Figure 24: Measure the digital length of the central incisor using the ruler tool.

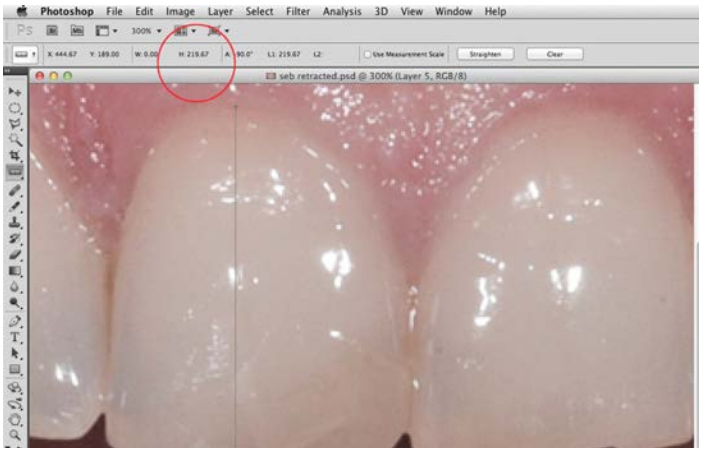
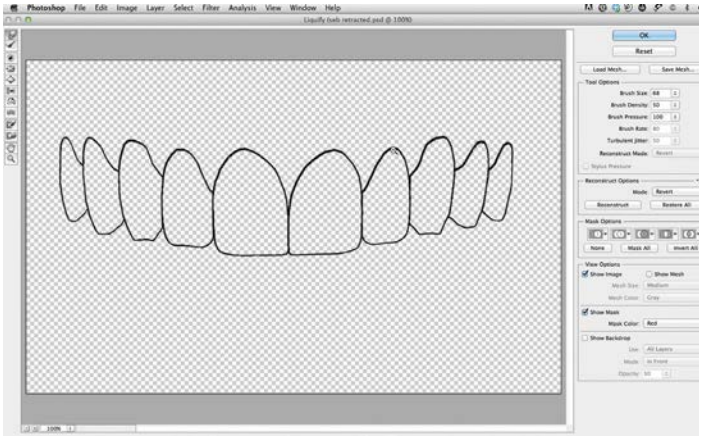


Figure 25: Measure the new digital length using the conversion factor created earlier.

Figure 26: Create a new transparent layer and mark the new proposed length with the pencil tool.

Figure 27: Open the image of the chosen tooth grid in Photoshop and "drag" the grid onto the image of teeth to be smile designed. This will create a new layer in the image to be smile-designed.

Figure 28: Adjust the grid as required while maintaining proper proportions by using the free transform tool in the edit menu.



Figures 29: Modify the grid shape as necessary using the liquefy tool.

Applying a New Proposed Tooth Form

Next, follow these steps:

1. After performing the smile analysis and digital measurements, choose a custom tooth grid appropriate for the patient. Select a tooth grid based on the width-to-length ratio of the planned teeth (e.g., 80/70/90 or 80/65/80). Open the image of the chosen tooth grid in Photoshop and "drag" the grid onto the image of teeth to be smile-designed **(Fig 27)**.
2. If the shape or length is deemed inappropriate, press the command button (control button for PCs) and "z" to delete and select a suitable choice.
3. Depending on the original image size, the tooth grid may be proportionally too big or too small. To enlarge or shrink the tooth grid created (with the layer activated), press command (or control) and "t" to bring up the "free transform" function. While holding the shift key (holding the shift key allows you to transform the object proportionally), click and drag a corner left or right to expand or contract the custom tooth grid. Adjust the size of the grid so that the outlines of the centrals have the new proposed length. Move the grid, as necessary, using the move tool so that the incisal edge of the "tooth grid" lines up with the new proposed length **(Fig 28)**.
4. Areas of the grid can be individually altered using the liquefy tool **(Fig 29)**.

Digitally Creating New Esthetic Teeth

Next, follow these suggested steps:

1. With the new tooth grid layer and the magic wand tool both activated, click on each tooth to select all the teeth in the grid **(Fig 30)**.
2. Expand the selection by 2 pixels in the select>modify>expand menu **(Fig 31)**. Note that the selection better approximates the grid. You can expand the selection or contract, as necessary, using the same select>modify menu.

Figure 30: Select all of the teeth in the grid by activating the "magic wand" selection tool and then clicking on each tooth with the grid layer activated (highlighted) in the layers palette.

Figure 31: Use the selection modify tool to expand the selection to better fit the grid shape.

Figure 32: Activate the layer of the teeth by clicking on it. Blue-colored layers are active.

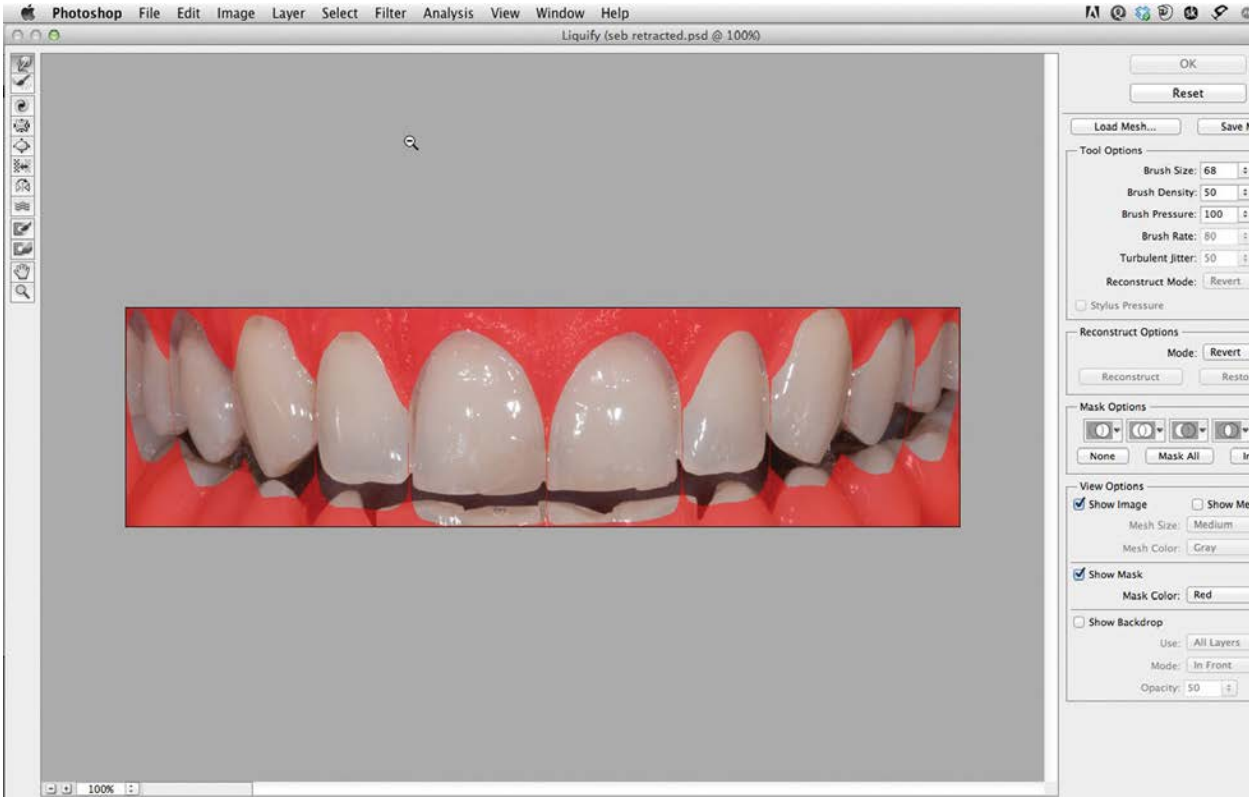


Figure 33: With the layer of the teeth highlighted, choose "liquefy"; a new window will appear with a red background called a "mask."

3. Activate the layer of the teeth (cheeks-retracted view) by clicking on it **(Fig 32)**.
4. Next, activate the liquefy filter (you will see a red mask around the shapes of the proposed teeth). The mask creates a digital limit that the teeth cannot be altered beyond. This is similar to creating a "mask" with tape for painting a shape **(Fig 33)**.
5. Use the "forward warp" tool by clicking and dragging on an area of the existing tooth to mold/shape the tooth into the shape of the new proposed outline form **(Fig 34)**.
6. Repeat this for each tooth. If you make a mistake or don't like something, click command (or control) and "z" to go back to the previous edit **(Fig 35)**.

Adjusting Tooth Brightness

The following steps are recommended next:

1. Select the whitening tool (dodge tool) to brighten the teeth. In the dodge tool palate, click on mid-tones and set the exposure to approximately 20%. Click on the areas of the tooth you want brightened **(Figs 36 & 37)**.
2. Alternatively, with the teeth selected, you can use the brightness adjustment in the image/adjustments/brightness/contrast menu.
3. Performing the changes on only one side of the mouth allows the patient to compare the new smile design to his/her original teeth before agreeing to treatment.

Create a Copy

To save information you've created for presentation to the patient, follow these tips:

1. Go to "file" and "save as."
2. When the menu opens up, click on the "copy" box.
3. Name the file at that step.
4. Save as a JPEG file type.
5. Designate where you want it saved.
6. Click "save."

A file of the current state of the image will be created in the designated area. You can now continue on the image and save again at any point you want.

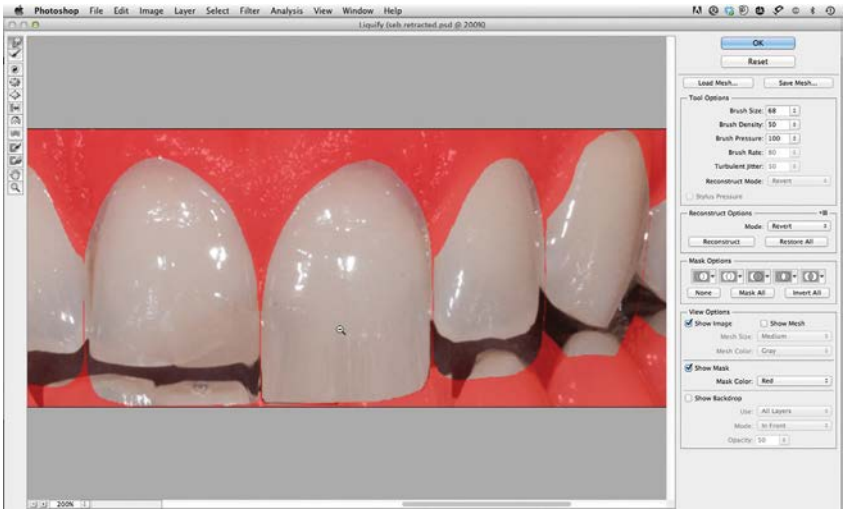


Figure 34: Shape one tooth at a time as needed by selecting "wand."

Figure 35: After all the teeth have been shaped, use the liquefy tool.

Figure 36: Tooth brightness is adjusted by choosing commands from the "dodge" tool menu or "image adjustments" menu.

Conclusion

Knowledge of smile design, coupled with new and innovative dental technologies, allows dentists to diagnose, plan, create, and deliver esthetically pleasing new smiles. Simultaneously, digital dentistry is enabling dentists to provide what patients demand: quick, comfortable, and predictable dental restorations that satisfy their esthetic needs.

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Figure 37: Image of all the teeth bleached with the "dodge" tool.

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Direct Resin VENEERS

Case Type V for AACD Accreditation

Frank J. Milnar, DDS, AAACD
Jenifer Wohlberg, MDT, AAACD
Illustration by Zach Turner

INTRODUCTION

Clinicians undertake the American Academy of Cosmetic Dentistry (AACD) Accreditation process to achieve excellence and more sophisticated dentistry for their patients. The process itself is one of advanced education, discovery, and professional enhancement that can be attempted only after many years of learning from others.

Fortunately, the AACD provides many avenues through which to pursue collaborative learning and skills development, whether through the *jCD* or the annual scientific session, through regional meetings or collegial interactions with peers. The authors of this article, Frank Milnar, DDS, AAACD; and Jenifer Wohlberg, MDT, AAACD, have long availed themselves of such opportunities.

In their words: "We have formed a partnership wherein we each have learned the major characteristics and subtle nuances of each other's respective professions. For more than eight years, we have taught one another the concepts, tools, and processes we use to design restorations. Through this partnership, we both have gained a greater understanding of our own art, as well as a greater breadth of knowledge in cosmetic dentistry as a whole."

KEY WORDS: Accreditation, direct composite veneers, shade matching, layering

"Lifelike representation of color is among the most important characteristics of an esthetic direct restoration and is necessary to achieve Accreditation."

For example, when undertaking Accreditation Case Type IV or Case Type V restorations, it is by first performing an esthetic mock-up—similar to the techniques performed by ceramists prior to fabricating indirect restorations—that the ultimate treatment can be visualized for execution. Placing composites to evaluate their effect on the treatment outcome simulates the ceramic-layering shade-mapping strategies employed by ceramic artists when recreating lost tooth structure.

Such talents, knowledge, and skill are required for successful completion of Accreditation Case Type IV, in which Class IV direct resin restorations are placed on the maxillary incisors to replace at least 10% of the facial surface; this aspect is structurally compromised, and the structural compromise should involve the mesial and/or facial, lingual, and incisal aspects. Diastema closures should have a 1 mm or greater diastema, requiring composite placement on two adjacent teeth. Likewise, for Case Type V, six or more direct resin veneers are placed to demonstrate the technique performed to restore the maxillary incisors and canines.

When such cases are submitted for Accreditation, several factors are evaluated to assess the restorations' success. Drawing from one's education, skill development, and interdisciplinary knowledge enhances the ability to approach the clinical challenge with an armamentarium of options for accurately and appropriately recreating lifelike color, morphology, texture, internal characterization, and shape.[1-3]

This article demonstrates how the approaches for planning direct composite layering and ceramic fabrication cross interdisciplinary boundaries and lend themselves to achieving a mutual objective: providing patients with excellent options for predictable, lifelike restorations. The perspectives of two AACD Accredited members and former Accreditation chairs are presented.

Figure 1: Displeasing composite veneer on tooth #8.

Figure 2: Preoperative view showing lack of luminosity.

Figure 3: Prior restoration with unsuitable surface structure.

FACETS OF COLOR DESIGN

There are six facets of color design to consider when conceptualizing a composite restoration:

- **form**
- **surface texture**
- **hue**
- **chromacity**
- **translucency**
- **luminosity.[3]**

These factors determine the optical characteristics of the restoration.

CASE PRESENTATION

STEP 1: TREATMENT PLANNING

A 46-year-old male patient presented with an esthetically displeasing composite veneer on tooth #8 that another dentist had unsuccessfully attempted to place on five separate occasions **(Fig 1)**. The previously placed composite veneer lacked luminosity and was visibly dull compared to the adjacent teeth **(Fig 2)**. The veneer also did not mimic the anatomic form of the natural tooth, lacking proper incisal margin characterizations. The restoration did not demonstrate appropriate surface structure or internal intensities (i.e., striations/staining), and failed to match the hue, translucency, and value of the patient's natural dentition **(Fig 3)**. Essentially, the old veneer did not meet any of the esthetic requirements of AACD Accreditation standards. This is why dentists must possess a comprehensive understanding of the materials and techniques required to place an esthetic restoration before attempting to perform the procedure.

Two options for restoring the tooth were discussed with the patient:

- A direct composite veneer, the benefits of which would include easy repair and conservation of more of the natural tooth structure.
- An indirect restoration fabricated by a ceramist, which would provide greater color homogeneity and custom staining.

At this time the patient was more interested in an indirect procedure.

STEP 2: CERAMIST SHADE MATCHING

With the patient present at the dental laboratory, the ceramist used the VITA 3D-Master shade guide tabs (Vident; Brea, CA) to shade match the patient and "map" his color plan. This was accomplished by taking a number of photographs at the incisal edge with varying shades, as the camera picks up characterizations and luster the eye may miss **(Figs 4 & 5)**.

The ceramist then created a color map of the values of the proposed restoration **(Fig 6)**. This map included color characteristics such as value, hue, and chroma. This patient required VITA shade 2M1 for gingival color, shade 1M1 for dentin body, shade 2M1 for enamel color, and shade EE9 for translucence intensities. After completing the shade match with the ceramist, the patient returned to the dentist's practice.

" The hallmark of a clinician's knowledge in cosmetic dentistry is their ability to properly identify and reliably replicate the features inside—and on the surface of—natural teeth. "

Figure 4: Ceramist begins shade matching.

Figure 5: Variety of shades used for characterization and luster.

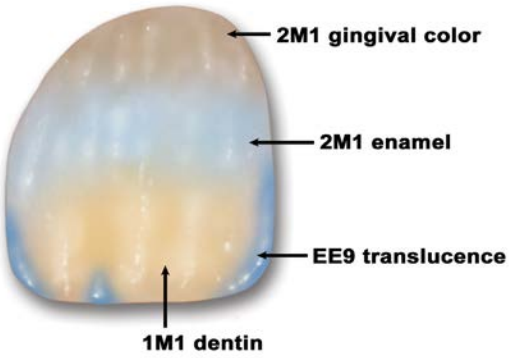

Figure 6: Color map drawn by ceramist.

STEP 3: DENTIST SHADE MATCHING

Although he initially had preferred an indirect procedure, the patient ultimately chose to proceed with the direct composite veneer restoration. He came to this decision because, after careful consideration, he wanted a restoration that was repairable and reversible, and to save his tooth structure in the hope that future products will improve for better results. A universal supra-nanohybrid composite (Estelite Omega, Tokuyama Dental America; Encinitas, CA) was selected based upon its handling capabilities and enhanced optical properties.[4,5]

The first esthetic preview (i.e., shade match) was the dentin layer. Dentin denotes the basic hue of the tooth and adds to the fluorescence and chromatic interpretation of restorations. This was accomplished by placing small amounts of dentin shades of composite on the enamel surface of tooth #9. DA1 was placed on the left side of the tooth, and DA2 was placed on the right side (Tokuyama) **(Fig 7)**.

Next, the esthetic previews for the enamel layers were established. The cervical portion of the tooth exhibited a lighter color, with Type 2[6] intensities (i.e., small cloud-like milky white stains), so Milky White (MW) (Estelite Omega) was previewed **(Fig 8)**.

Toward the incisal edge, Enamel B1 (EB1, Estelite Omega) was previewed **(Fig 8)**. The incisal edge is a very important area of color design; this is the area of enamel where the patient's window-like Type 4[6] opalescence and Type 1[6] characterization features would be built up.

STEP 4: TOOTH PREPARATION

Using a diagnostic model that was made prior to the restorative procedure, a putty stent was fabricated (Aquasil EasyPutty, Dentsply Caulk; Milford, DE) for volumetric determination of incisal/lingual width, incisal edge, and incisal embrasure **(Fig 9)**. Because the incisal edges seemed consistent, no mock-up was made.

The patient was anesthetized (Septocaine, Septodont, Novocol Pharmaceutical of Canada; Cambridge, ONT) and no retraction cord was placed. The existing composite restoration on #8 was carefully removed with the intention of keeping the enamel intact, as enamel is a much better bonding substrate.[7] The tooth was prepared with the New Horizon Composite Polishing System #K0097 (Brasseler USA; Savannah, GA). The preparation left sufficient room for creating incisal characteristics and opalescence **(Fig 10)**.

Figure 7: Shade matching by dentist for dentin, DA1 (left) and DA2 (right).

Figure 8: Preview of enamel colors, Milky White (middle) and B1 (incisal edge).

Figure 9: Volumetric determination using a putty stent.

Figure 10: Prepared tooth.

A disposable retainer and matrix (Omni-Matrix, Ultradent; South Jordan, UT) was cut to 15/1000ths or "dead soft." An acid-etch phosphoric acid (Tokuyama) was applied to the enamel and left to penetrate for 15 seconds, then rinsed. The etchant was then applied to the dentin, left to penetrate for 10 seconds, and rinsed **(Fig 11)**. After etching, the frosty appearance of the exposed dentin was visible on the distal/gingival surface **(Fig 12)**.

A dentin bonding agent (Bond Force, Tokuyama) was carefully applied, air-thinned, and polymerized, completing the preparation **(Fig 13)**.

STEP 5: COMPOSITE LAYERING PROCESS

The first increment of composite was layered onto the preparation. Dentin DA2 (Estelite Omega) was applied to the gingival third and striations were created to diffuse the light, consistent with the anatomy of tooth #9 **(Fig 14)**.[8] Dentin shade DA1 (Tokuyama) was added, then Translucent (TRANS) (Tokuyama) was used to build an incisal frame on which the second dentin shade DA2 would be placed. Characteristics of these composites would generate in the mamelon area a chromatic interpretation of the substructure of the tooth consistent with #9, especially the striations and light-reflective properties **(Fig 15)**.[9]

Next, on the mesial portion of #8, an increment of high-value translucent MW was placed to raise the value and create characterizations similar to those observed in #9, and light-cured **(Fig 16)**. The entire substructure was applied freehand in the gingival margin using a gold-grip esthetic contouring instrument (Clinician's Choice; New Milford, CT), creating chromatic interpretation and opalescence **(Fig 17)**.[10]

With the dead soft matrix (Omni-Matrix) back in place, the final enamel layer was applied. Enamel B1 (EB1, Tokuyama) was placed on the gingival third of #8, MW was placed in the center of the tooth, and TRANS was placed on the incisal third. All three shades were blended into a homogenous mixture and light-cured. This enamel blend reflected the value observed in the natural tooth **(Fig 18)**.[11]

STEP 6: CREATING LIFELIKE ANATOMY

Using a series of discs (Super-Snap SuperBuff, Shofu Dental; San Marcos, CA), a light sanding was performed to create the basic outlaying geometric shape of the tooth consistent with the adjacent tooth, and a nonporous, smooth surface free of imperfections. Shape was then verified in the putty stent **(Fig 19)**.

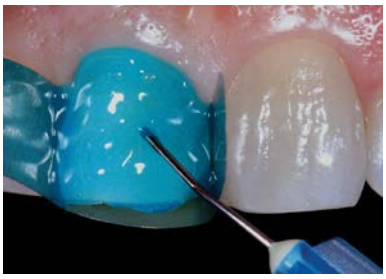

Figure 11: Etchant applied.

Figure 12: Frosty-looking dentin.

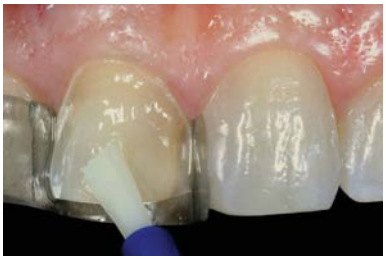

Figure 13: Dentin bonding agent applied.

Figure 14: Application of DA2 composite.

Figure 15: Composite characterization.

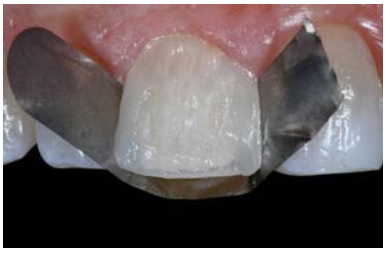

Figure 16: High-value translucent placed and light-cured.

Figure 17: Freehand application of substructure.

Figure 18: Enamel blend matching natural tooth.

Figure 19: Creation of shape with light sanding.

Transitional line angles were drawn on the mesial and distal aspects of #9 and replicated on the composite veneer. Using Super-Snap discs, the angles were modified on the veneer, then redrawn to verify illusory symmetry **(Fig 20)**.

The micro-morphology of the cervical third of the tooth was created using green stones (Dura-Green, Shofu).[12] A #8850-31-014 diamond bur (Brasseler) was used to create the surface texture and micro-architecture of the tooth **(Fig 21)**.[13] Before finishing and polishing, it was imperative to ensure mimicry of light transmission of the natural tooth, so the facial surface and micro-morphology of the structure were refined using carbide finishers (Robot shank carbide CTF-FG yellow and white, Shofu) **(Fig 22)**.

The final polish was completed using polishers, paste, and discs (OneGloss, Direct Dia, and Super-Snap Mini Buffs, Shofu) **(Fig 23)**.[14]

STEP 7: DELIVERING ESTHETIC IDEALS

Upon inspection of the natural smile and completed veneer, it was determined that the adjacent tooth was mimicked both in color and shape **(Fig 24)**. The retracted intercuspal view verified a good illusion of natural smile design according to light transmission and chromatic values **(Fig 25)**.

The patient presented an open embrasure between #8 and #9; as this feature is more graceful and less masculine, it was suggested that his smile could be further enhanced by freehand bonding a small amount of composite to close the embrasure, and adding a small amount to the mesial aspect of #10. This was accomplished using acid etching and applying MW composite alone. The result of modifying the incisal edges and embrasure from a gender standpoint actually made his smile look stronger and more masculine **(Fig 26)**. The retracted view demonstrates the dramatic effect of the small modification **(Fig 27)**. When the original build-out is viewed with the modified build-out image superimposed over it, it is easily visible that just a small surface differential created a different smile concept **(Fig 28)**.

The incisal edges and widths were symmetrical, the embrasures were symmetrical, and the mesial and distal transition angles were created successfully **(Fig 29)**. The anterior teeth, photographed in black and white, illustrate that appropriate values were recreated as well **(Fig 30)**.

Figure 20: Lines drawn to verify symmetry.

Figure 21: Forming surface texture and micro-architecture.

Figure 22: Refining with carbide finishers.

Figure 23: Final polish.

Figure 24: Inspection of natural smile.

Figure 25: Open embrasures between #8 and #9.

Figure 26: Modifications for a more masculine look.

Figure 27: Retracted view showing a small change with a big impact.

Figure 28: First result image with final result image placed over it.

Figure 29: Successful incisal edges, embrasures, and mesial and distal angles.

Figure 30: Black-and-white image illustrating appropriate values.

CONCLUSION

The patient was extremely satisfied with his new composite veneer and smile enhancement, which is the requisite effect when placing an esthetic restoration. To an AACD Accreditation Examiner, the hallmark of a clinician's knowledge in cosmetic dentistry is their ability to properly identify and reliably replicate the features inside—and on the surface of—natural teeth.[15] The restoration detailed here expertly mimicked the adjacent tooth in form, light transmission, and chromatic interpretation. It also demonstrated excellent incisal width and symmetry, meeting all of the AACD standards; and excellent, artistically crafted esthetics.[16] Additionally, it was completed using direct composite, which means lower cost to the patient.

As noted earlier, this article was written with Accreditation standards in mind. However, anyone who wishes to achieve lifelike composite resins would benefit from following the strategies described.

For comments regarding this case, please turn to page 121.

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Dr. Milnar is an Accredited Member of the AACD. He also is an Accreditation Examiner and *jCD* Editorial Review Board member. Dr. Milnar practices in St. Paul, Minnesota.

Disclosure: Dr. Milnar developed the New Horizon Composite Polishing System #K0097 mentioned in this article.

Ms. Wohlberg is an Accredited Member of the AACD and was the AACD Laboratory Technician Accreditation Chair (2003-2005). She is the president of Valley Dental Arts in Stillwater, Minnesota.

Disclosure: Ms. Wohlberg did not report any disclosures.

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Direct Resin Veneers: Case Type V for AACD Accreditation

Bradley J. Olson, DDS, FAACD, FAGD

> **"Success is peace of mind which is a direct result of self-satisfaction in knowing you did your best to become the best you are capable of becoming."**
>
> **–John Wooden**

John Wooden is arguably the greatest coach in the history of college basketball. He won a national championship as a player; that would be enough for almost anyone in basketball. He won a national championship as a coach, and *that* would be enough for almost anyone in basketball. But he went on to win 10 NCAA championships in a 12-year period. John Wooden was driven to be the best he could be and that meant challenging himself year in and year out.

The composite restoration on tooth #8, as described in the preceding article, could be considered a satisfactory restoration. The composite restoration in mid treatment prior to cutback and final contour could be considered a satisfactory restoration. But Dr. Milnar saw something more. Pushing ourselves to the next level of treatment for our patients requires a paradigm shift in seeing elements of shape, shade, and contour. Any dentist or laboratory technician that has accepted the challenge of AACD Accreditation will tell you their growth was exponential regardless of their starting point. Dr. Milnar has demonstrated the first step in growth, and that is the fact that we cannot treat or correct what we do not see.

The second step toward growth is to gain the skill set to transfer what the brain visualizes into a final product. Micro esthetic components of dental anatomy, color and shade, and smile design must be communicated to our ceramist when we fabricate indirect restorations. The ceramist can then custom map the dentist's vision. When working with direct resin, the outcome rests solely with the restorative dentist. This can be an intimidating test when six or more direct restorations are indicated. Dr. Milnar's collaboration with master ceramist Jenifer Wohlberg proved to help guide and elevate this case to the next level. Growth rarely begins with a full sprint. First steps lead to a steady gait, followed by full strides. Accomplishing excellence with one tooth eases the road and builds confidence for greater challenges.

Finally, Dr. Milnar has demonstrated the third step in growth: to share knowledge by teaching and mentoring. An acceptable resin became a masterpiece of contralateral balance, labial anatomy, surface finish and texture, color, translucency, and characterization in harmony with the natural dentition.

I challenge you to find your path to growth, and close with another quote from John Wooden: "It's the little details that are vital. Little things make big things happen."

Dr. Olson is an AACD Accreditation and Fellowship Examiner. He was Accreditation chair from 2004-2006. Dr. Olson practices in Waldorf, Maryland.

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Direct Extrinsic Characterization

Maximizing Esthetics of Fixed Interim Restorations

Chris Barwacz, DDS, FAGD,
Maria Marcela Hernandez, DDS, MS

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.

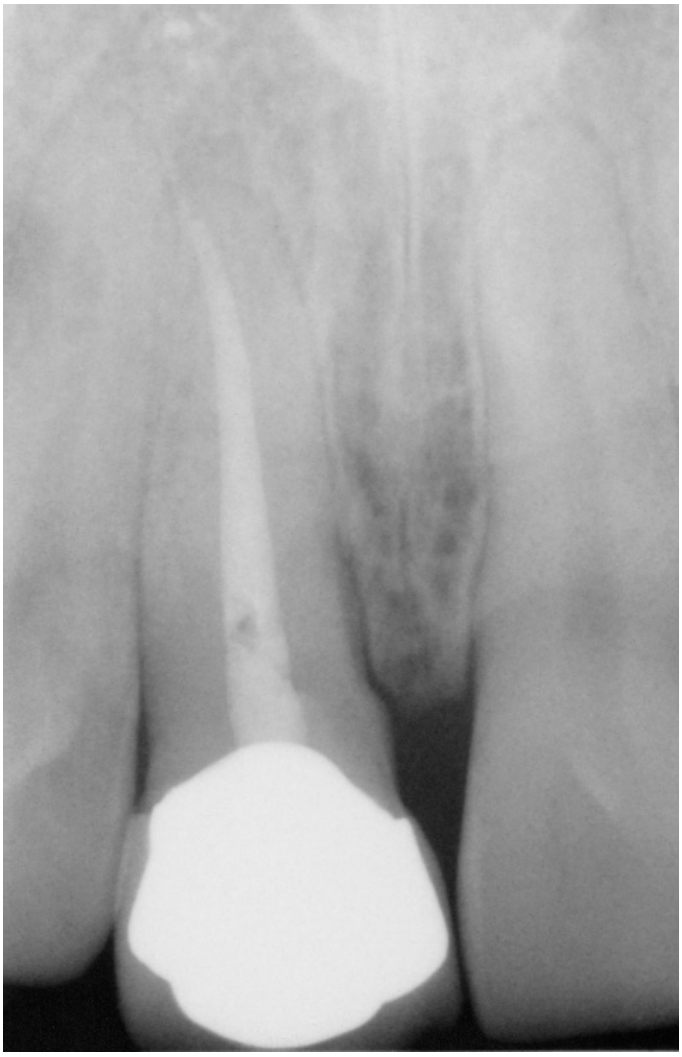

Figure 1b: Initial periapical radiograph demonstrating root proximity of #7 and #8, preventing an immediate implant placement approach.

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.

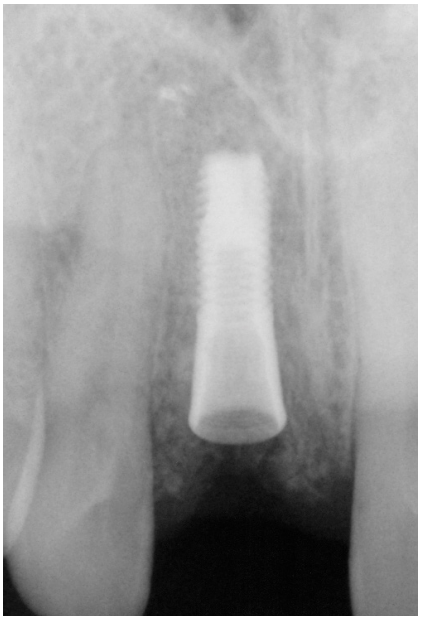

Figure 4: Immediate postoperative radiograph of implant placement.

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.

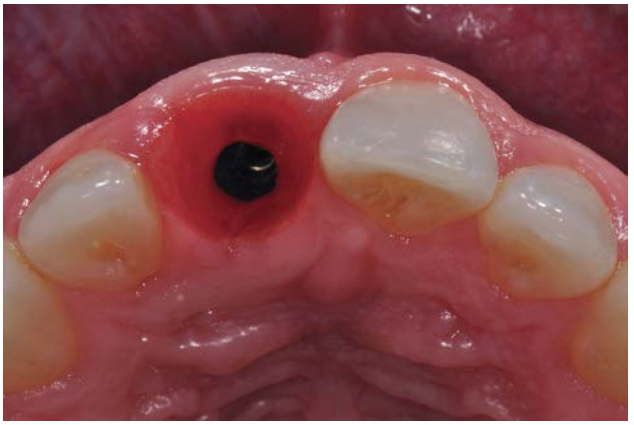

Figure 9b: The developed peri-implant sulcus architecture viewed from the occlusal aspect after provisionalization.

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.

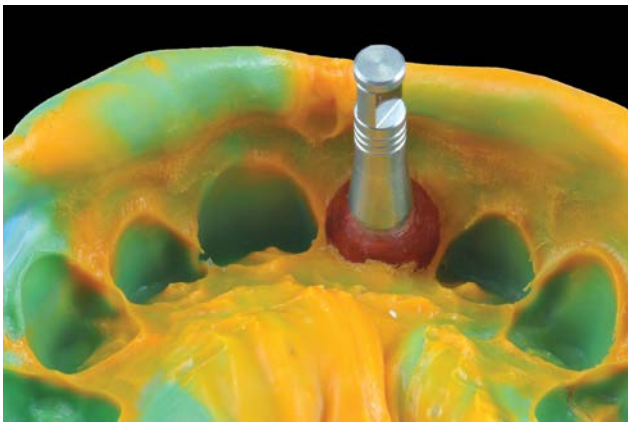

Figure 10b: The master impression with the implant analog displacing the resin modifier apical to the gingival zenith.

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-

> "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."

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

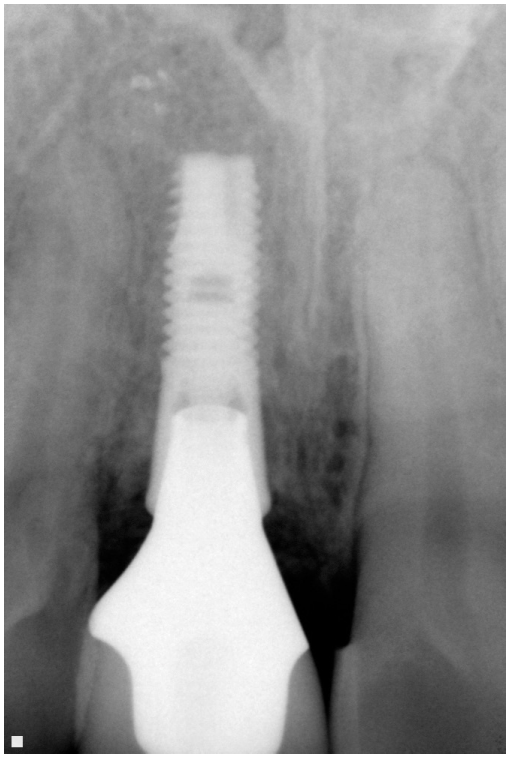

Figure 13: Final periapical radiograph of the completed implant-supported restoration.

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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Disclosures: The authors did not report any disclosures.

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General Information

This continuing education (CE) self-instruction program has been developed by the American Academy of Cosmetic Dentistry (AACD) and an advisory committee of the *Journal of Cosmetic Dentistry*.

Eligibility and Cost

The exam is free of charge and is intended for and available to AACD members only. It is the responsibility of each participant to contact his or her state board for its requirements regarding acceptance of CE credits. The AACD designates this activity for 3 continuing education credits.

Testing and CE

The self-instruction exam comprises 10 multiple-choice questions. To receive course credit, AACD members must complete and submit the exam and answer at least 70% of the questions correctly. Participants will receive tests results immediately after taking the examination online and can only take each exam once. The exam is scored automatically by the AACD's online testing component. The deadline for completed exams is one calendar year from the publication date of the issue in which the exam appeared. The exam is available online at www.aacd.com. A current web browser is necessary to complete the exam; no special software is needed.

Note: Although the AACD grants these CE credits, it is up to the receiving governing body to determine the amount of CE credits they will accept and grant to participants.

Verification of Participation (VOP)

VOP will be sent to AACD members via their MyAACD account upon pass completion. Log onto www.aacd.com to sign into your MyAACD account.

For members of the Academy of General Dentistry (AGD): The AACD will send the AGD proof of your credits earned on a monthly basis. To do this, AACD must have your AGD member number on file. Be sure to update your AGD member number in your AACD member profile on MyAACD.com.

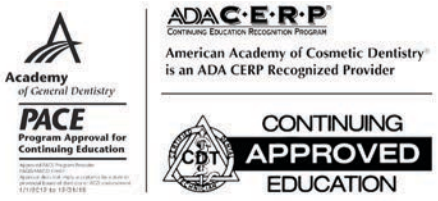
All participants are responsible for sending proof of earned CE credits to their state dental board or agency for licensure purposes.

Disclaimer

AACD's self-instruction exams may not provide enough comprehensive information for participants to implement into practice. It is recommended that participants seek additional information as required. The AACD Self-Instruction Program adheres to the guidelines set forth by the American Dental Association Continuing Education Recognition Program (CERP), and the AGD Program Approval for Continuing Education (PACE).

Questions and Feedback

For questions regarding a specific course, information regarding your CE credits, or to give feedback on a CE self-instruction exam, please contact the AACD Executive Office by e-mailing meetings@aacd.com or by calling 800.543.9220 or 608.222.8583.



ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP does not approve or endorse individual courses or instructors, nor does it imply acceptance of credit hours by boards of dentistry. AACD designates this activity for 3 continuing education credits. Concerns or complaints about a CE provider may be directed to the provider or to ADA CERP at www.ada.org/goto/cerp.

(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

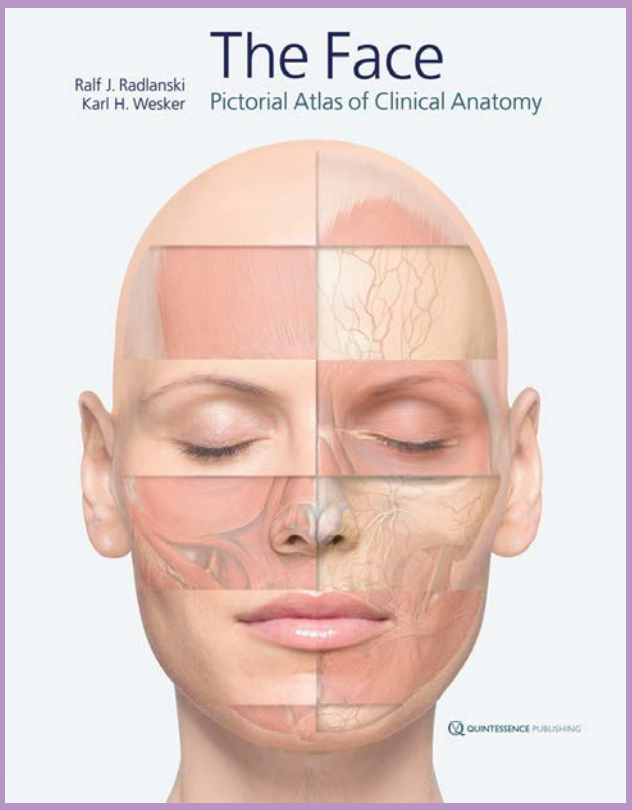
a) of indirect interim restorations can be achieved via additive or subtractive methods.
b) of direct/indirect interim restorations is best achieved by surface application of tints and opaquers.
c) of interim restorations is generally not desired by demanding patients.
d) is typically not a requirement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

To see and take the complete exam, log onto www.aacd.com.

jCD Book Review

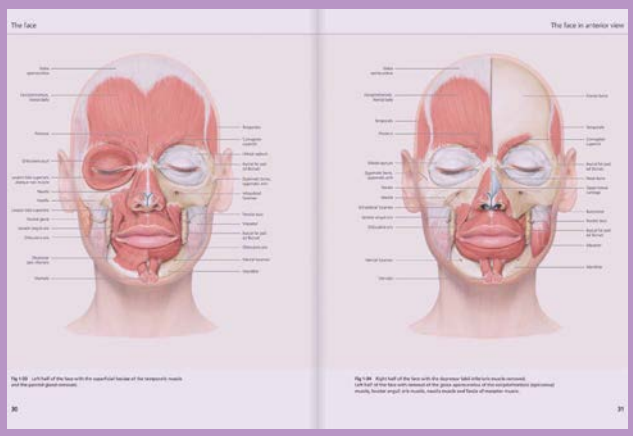
The *Journal of Cosmetic Dentistry's* Book Review is an opinion piece highlighting works that are currently available from publishers in the dental industry.

Title: *The Face: Pictorial Atlas of Clinical Anatomy*
Authors: Ralf J. Radlanski and Karl H. Wesker
Publisher: Quintessence Publishing



The Face presents a survey of head and neck anatomy that focuses on spatial descriptions of structures rather than on their functional significance. The book's precise, delicately shaded color plates will enable readers to quickly identify anatomical features (larger plates would have enhanced this even more). Multiple views of the same location allow for a thorough and easy-to-digest description of vessels, nerves, muscles, and bones. Although closer proximity to the specific described images would have been helpful, the image captions provide meticulously detailed descriptions of muscle attachments/insertion and courses of vessels/nerves. The inclusion of aging facial anatomy is very useful and is relatively rare in books of this nature.

The book is well written, but bullet points addressing muscle insertions and vessel and nerve courses might make for more efficient information gathering. A summary of major muscle and nerve functions (especially cranial nerves), in table form, would have been useful (e.g., those relating to facial expression, chewing, swallowing). *The Face's* detailed, clean, and accurate illustrations are extremely valuable for learning facial and oral anatomy.



A Special Gift to *jCD* Readers:

Take advantage of a special offer from Quintessence Publishing! As an AACD member, you can receive a preview download of *The Face* and 25% off the regular price. Simply enter promo code JCD2013 at checkout. To take advantage of this discount, visit: http://www.quintpub.com/jcd/

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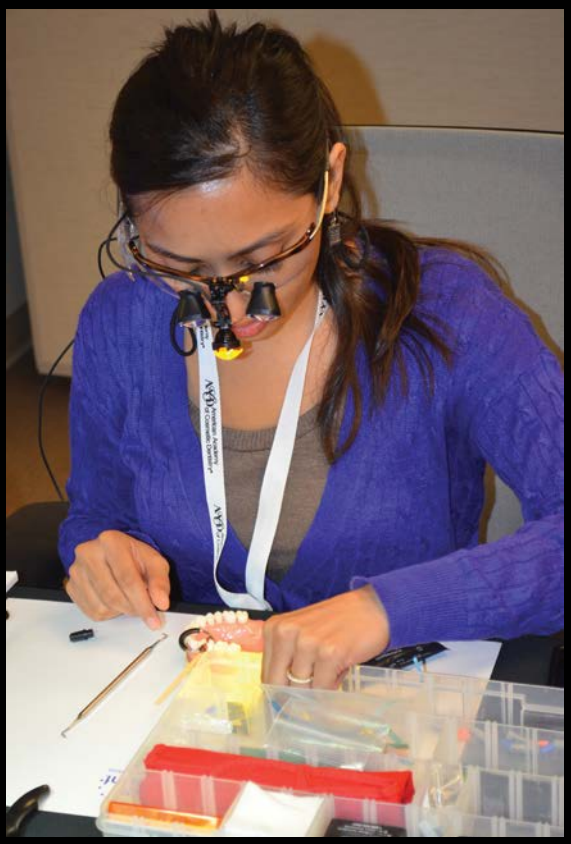
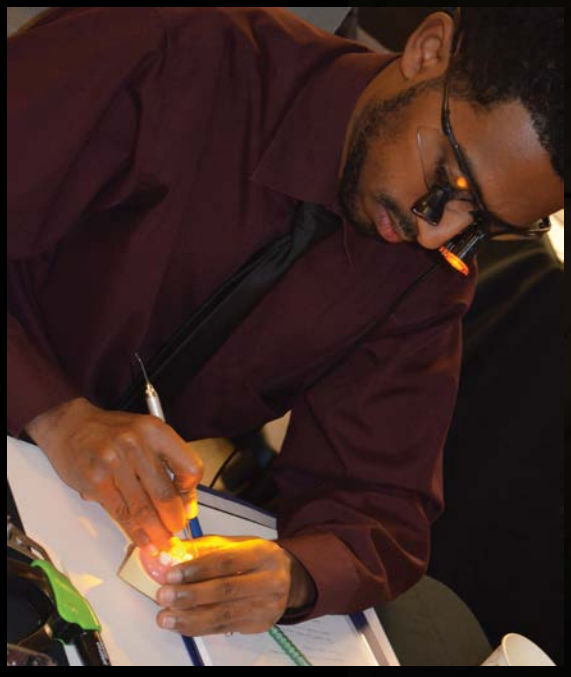


"This course was amazingly helpful. Facilities were excellent and staff was very accommodating. I will be attending future events."

- AACD Unplugged attendee



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Advertiser Index

Errata

jCD 2012 Winter;28(4):22.

The article, "Using the Erbium Laser to Remove Porcelain Veneers in 60 Seconds," by Glenn A. van As, DMD, showed an image, Figure 2, on page 22. The caption *should* read, Figure 2: An approximately 200-300µm deep ablation crater made by multiple pulses from an erbium laser.

That image is the property of Peter Rechmann, DMD, PhD, Dr. med. dent., School of Dentistry, University of California San Francisco. It was inadvertently published without his permission. *jCD* regrets the error.

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