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Strategies for Successful Esthetic Dental Treatment

STEPHEN R. SNOW, DDS

ABSTRACT The foundational principles of esthetic smiles reveal the direct influence of individual tooth alignment on dentofacial relationships. The use of clinical photography is an essential means to identify esthetic problems. Smile design provides an opportunity for effective communication to discuss treatment alternatives with the patient in the consultation process. The scope of treatment can be determined, and treatment limitations can be explained. Smile design findings influence preparation design, material selection, and laboratory communication for enhanced predictability and improved treatment success.

AUTHOR

Stephen R. Snow, DDS, is visiting faculty, University of California, Los Angeles, Center for Esthetic Dentistry; director, PERFECT Perspectives Advanced Dental Seminars, Danville, Calif., and in private practice emphasizing cosmetic restorative dentistry in Danville.

The prospect of performing cosmetic dental treatment is appealing. Recent media attention has heightened public awareness and increased demand for the services. Branding techniques that market specific products to patients rather than clinicians have enhanced patient inquiries for care as well. Since the services are often elective and directly requested by many patients, their willingness to accept treatment despite insurance coverage limitations may not be as restricted as with other treatment modalities.

Despite patient enthusiasm for optional procedures, however, the delivery of esthetic care presents many potential problems. There are many treatment alternatives available. Durability and performance of competing materials systems can be questionable. The appropriate scope of treatment may seem arbitrary. Selecting interdisciplinary strategies may be confusing as well.

The clinician needs an objective strategy to navigate through the patient examination and evaluation process. With objective consideration of the possible treatment alternatives that could be applied to meet the patient's goals, the proper treatment options can be presented and excellence in dental treatment can be delivered.

Esthetic Principles

Clinicians must be mindful of esthetic standards in evaluating how best to meet patient expectations. The more the elements of appearance deviate from known visual principles, the more likely patients will be disappointed with their smile. These principles are not dogmatic rules that must be applied and achieved for every patient.[1] Some patients are often disappointed with their appearance, however, they compare themselves to social and entertainment icons and perceive that they don't measure up. Although patients usually are focused on specific esthetic

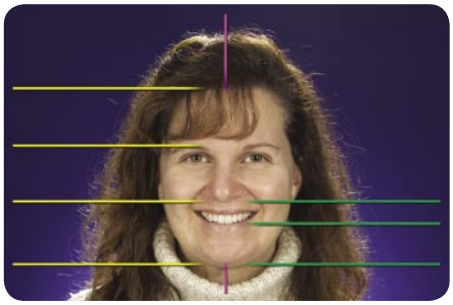

FIGURE 1. When viewed from a frontal perspective, the superimposed midline (magenta), upper/middle/lower thirds of the face (yellow), and lower third anatomical relationships (green) of this face are well-proportioned and conform to facial esthetic principles.

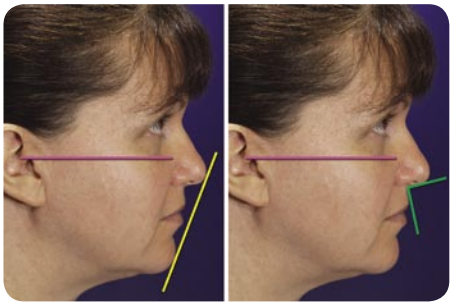

FIGURE 2. The Frankfurt horizontal (magenta) is parallel to the horizon in this sagittal perspective view. The maxillary lip is positioned approximately 4 mm posterior to the E-plane (yellow) while the nasolabial angle (green) is approximately 95 degrees.

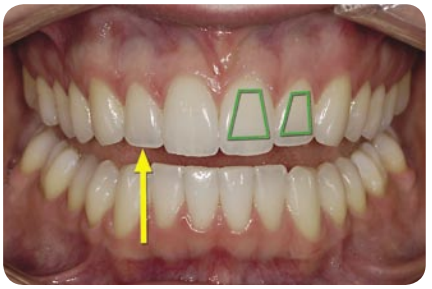

FIGURE 3. The proximofacial line angles combine with cervicofacial and incisofacial line angles to define the reflective "face" that accentuated the tapered appearance in this case. An increase in chroma from central incisor to canine is evident along with an anterior halo.

complaints, they are often unaware of the interrelation of multiple factors that combine to create the deficiencies they notice. It is prudent for clinicians to implement a disciplined approach in the diagnosis and subsequent delivery of dental care.

Esthetic principles can be categorized in three general groups: facial esthetic principles, dental esthetic principles, and dentofacial esthetic principles.[1]

FACIAL ESTHETIC PRINCIPLES comprise the overall skeletal relationships that affect the appearance of the middle and lower face. From the frontal perspective, the nasal, dental, and mental midlines ideally should coincide with the facial midline — a perpendicular line that bisects the interpupillary distance. The occlusal plane should be perpendicular to the midline and parallel to the horizon.[2,3] Attractive faces generally conform to the rule of thirds — with the upper, middle, and lower face segments each occupying approximately equal proportions of the vertical dimension of the face.[2,4,5] (**FIGURE 1**). Within the lower third of the face, the distance from the base of the nose to the incisal edge/lips should represent approximately one-third of the space, while the distance from the incisal edges/lips to the chin occupies the remaining two-thirds.[3] Attractive faces generally display an overall symmetry.[2,5] From a sagittal perspective, the nasolabial angle typically should fall in the range of 90 degrees to 95 degrees for males and 100 degrees to 105 degrees for females.[1,3,4] E-plane evaluation ideally reveals the maxillary lip is positioned 2 mm to 4 mm posterior to line from tip of nose to tip of chin.[1,3,4] (**FIGURE 2**).

DENTAL ESTHETIC PRINCIPLES comprise the nuances of contour and color characteristics of individual teeth. The contour of a tooth can be analyzed in three-dimensional views: from the facial, interproximal, and incisal. The "face" of a tooth has been defined as the reflective area inside the transitional line angles of the facial surface.[6] Although the silhouette of each tooth contributes to its appearance, the light reflection from the face of the tooth defines its apparent shape (**FIGURE 3**).

The inherent layers of tooth composition determine the characteristics of its color appearance. The internal dentin possesses the most chroma and opacity while the enamel is more translucent with significantly less chroma. These optical properties combine with the natural variations in thickness of each layer to produce a polychromatic shift within each tooth. Typically, there is also a polychromatic shift within the arch in which the canine teeth have a higher chroma and lower value than that of the central incisors[7] (**FIGURE 3**).

Additional color nuances are created by the subtle surface characteristics of teeth. A whitish surface haze may be present to form an enamel veil that partially obscures the visibility of the underlying tooth layers. Refraction caused by the incisal table of anterior teeth may scatter light to produce the appearance of a halo, a thin light line at their incisal edges (**FIGURE 3**). Finally, the appearance of tooth color is influenced by its surface topography.[6,8] The anatomy of developmental vertical undulations, the texture of lines and pits, and the relative glossy luster of a tooth alter the reflective qualities of its surface (**FIGURE 4**). The more light is reflected and scattered from the surface of a tooth, the less the underlying color is apparent.

DENTOFACIAL ESTHETIC PRINCIPLES are somewhat more complex in that they represent a blend of both facial structures and dental structures.[9] Theses principles are determined by tooth arrangement, the position of a tooth in space relative the others in the arch. These principles include the relative width and height of the teeth in the anterior segment.[1,6,11] The Golden Percentage of 1.618 : 1.0 can be converted and modified to the Golden Percentage for assessment of proportions and central incisor dominance as well as bilateral symmetry of maxillary anterior tooth width.[10]

When viewed from the frontal aspect, the width of each maxillary anterior tooth is measured mesiodistally at its maximum visible height of contour as viewed from the frontal aspect. The individual width of each tooth is divided

FIGURE 4. A combination of vertical developmental undulations, random surface irregularities and a satin quality luster all contribute to scattered light reflection that partially obscures the visibility of the underlying tooth color.

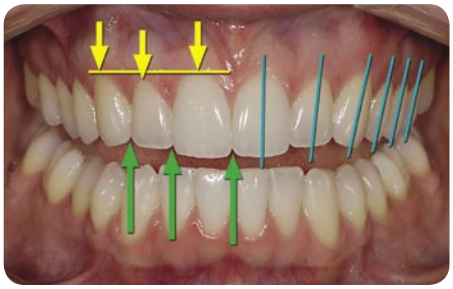

FIGURE 5. The mesial axial inclination (blue) increases from central incisor to canine and then remains constant in the posterior segment. The apical migration of the interproximal contacts with each successive distal contact matches the associated incisal embrasure (green). The "high-low-high" gingival zenith pattern is ideal in this case.

FIGURE 6. The smile line generally follows the curvature of the mandibular lip, and the esthetic zone is appropriately filled with "white space." The overall visual impact of the arrangement is pleasing from social distances despite obvious asymmetry in lateral incisor rotation.

by the sum total to reveal the percentage that each tooth contributes to the total canine-canine width. As an initial reference, the width percentage of the maxillary central incisors, lateral incisors, and canines should approach 22 percent; 16 percent; and 12 percent, respectively.[11] The width-height ratio of a maxillary central incisor should approximate 75 percent.[1,2,5] While these ratios produce pleasing anterior proportions representing the "media look" that patients may visualize and desire for their own smiles, minor variations are appropriate to blend with differing arch form and tooth arrangement appearance that accompany different facial shapes (i.e., longer versus shorter, wider versus narrower).[1,5,11,12]

A line extending from the height of the emergence of the tooth from the free gingival margin to the center of the incisal edge or incisal cusp tip implies the alignment of the axis of each tooth as its root extends into the alveolus. The maxillary anterior teeth ideally display mesial axial inclination gradation, with the central incisors appearing to be the most vertical and the lateral incisors and canines each tipping more toward the midline[5,6] (**FIGURE 5**). Beyond the canines, the remaining posterior teeth should display an inclination that is parallel to the canines.[5]

In an analysis of the normal position of interproximal contacts from mesial to distal within an arch, there is an apical migration. The occlusocervical position of interproximal contacts on an individual tooth reveals the distal contact is usually positioned further toward the apical than the mesial contact. As a result, the incisal embrasure form in the anterior also exhibits a gradation — increasing in depth from central incisor through canine (**FIGURE 5**). While minor differences are desirable, pleasing smiles exhibit a high degree of radiating symmetry.[2,5,6]

Dentofacial principles include evaluation of the collective appearance of the teeth in relation to the lips. Generally, the smile line should create a gentle, convex curve that follows the lower lip[1-3,6,12] (**FIGURE 6**). The oral structure revealed in a full smile should maximize white space (teeth) while appropriately minimizing black space (diastemas, excess buccal corridor space) and pink space (gingival display).[6] When the lips are retracted, the gingival frame components of the smile can be evaluated. Ideally, the emergence of the maxillary anterior segment should form a symmetrical "high-low-high" pattern in which the free gingival margin of the canine and central incisor are at the same height and the free gingival margin of the lateral incisor is positioned just incisal to that[1,5,6,9] (**FIGURE 5**). The gingival zenith represents the most apical point at which each tooth emerges from the free gingival margin. For an esthetically pleasing smile, it should be positioned distally to the center of each tooth within the maxillary anterior segment. The distal position gradually increases from the central incisor to the canine.

While each of these dentofacial principles can be evaluated independently, they are all affected by four specific tooth arrangement factors that affect the appearance of a smile:

- Arch form,[10,11]
- Buccolingual position of each tooth,
- Mesiodistal position of each tooth, and
- Rotation of each tooth.

If a smile presents a smooth evenly curved arch form free of buccolingual displacement, mesiodistal displacement, and rotation, the ideal dentofacial relationships are often present as well, creating a pleasing appearance.[11] A tooth arrangement with a collapsed palatal vault, buccoverted teeth, linguoverted teeth, overlapped teeth, diastemas, or rotated teeth often exhibits many violations of dentofacial principles and is unesthetic.

Documentation and Communication

While patients are often aware of esthetic problems they want resolved, they are often unaware of the interrelation of tooth arrangement factors in smile design. Even though there may be several elements simultaneously contributing to make a smile unattractive, it is only after the chief complaint is resolved that the next most egregious esthetic violation may become apparent to the patient. The cosmetic dentist

FIGURE 7. Wand-type intraoral cameras offer convenience for digitally capturing freeze frame images or video sequences. The small size of the wand unfortunately mandates the need for a small internal sensor with low resolution. The images may appear pixelated and distorted.

FIGURE 8. Digital single lens reflex camera systems allow use of macro (close-up) lenses with manual focus for repeatable diagnostic magnification. The large camera body can accommodate a large sensor offering high resolution and superior color accuracy.

FIGURE 9. This image was captured with a wand-design intraoral camera. The pixel dimensions of the image were 640 x 480. Note the uneven lighting, grainy/pixelated appearance, and wide angle distortion.

should possess a wealth of knowledge and experience in order to make appropriate treatment recommendations to address these concerns. Clearly, this perspective is not shared initially by the patient. The clinician must have a means to introduce smile design principles to patients for their consideration prior to treatment.

Routinely, dentists perform comprehensive evaluations for patients as they begin care in the office. Comprehensive clinical examination includes reviewing the medical history, assessment of temporomandibular joint and musculoskeletal function, evaluation of occlusal function and harmony, assessment of surrounding soft tissues, examination of periodontal tissues, and an evaluation of each tooth, both clinically and radiographically.

Beyond objective written documentation regarding the presence or absence of positive findings in these categories, the dentist must also consider methods for the documentation of the subjective esthetic elements of the smile. There is no question that photography presents the most effective way to record pretreatment conditions and post-treatment results. Accurate clinical photography has become an integral part of the standard of care for appropriate documentation of the teeth and surrounding structures.

There are currently two prevalent modalities used for clinical photography in the dental office: fiber optic "wand" camera systems, and digital single-lens reflex camera systems (**FIGURES 7-8**). Both systems record light with a solid-state sensor through an electrical reaction. A charge-coupled device, CCD, or a complimentary metal oxide semiconductor, CMOS, photodiode detector stores an electric charge that corresponds to the amount of light that strikes each portion of the sensor. Initially the electrical energy is converted into individual dots of digital color information that are combined to create the final image. Each dot of color data represents the basic visible unit of the detail of the digital image. Each picture element is called a "pixel."[13] The greater the number of pixels captured by CCD or CMOS sensor, the better the quality of the recorded image detail.[13,14]

The first wand system was the Fuji Dentacam introduced in 1986. Since that time, several manufacturers have entered the marketplace with similar products, but the units have become more compact and affordable. The wand design mimics an intraoral dental mirror to facilitate a visual "tour" of the mouth with the potential for freeze frame as well as video capture. Input and subsequent image review are directly stored to and retrieved from a local computer hard drive with proprietary software. While these systems are essentially "plug-n-play," the resolution and quality of the resulting images is mediocre at best (**FIGURE 9**).

Digital camera systems provide the alternative method for intraoral photography. Although there are a many digital cameras on the market for general photography that all allow rapid visualization of captured images, repeatable diagnostic dental photography requires a digital single-lens reflex camera system that allows interchangeable lens selection.[14] Macro lenses with a fixed focal length designation of 100 mm to 105 mm provide the ideal combination of magnification ability and working distance convenience for dental purposes.[15] The resolution and color accuracy are far superior to that of wand-type systems (**FIGURE 10**). Manual focus capability is required to create images with useful magnification ratios ranging from 1:1 (for close-up views) to 1:10 (for full-face images).

The camera body coordinates the functions of the image capture by regulating the amount of light that is allowed to expose the digital sensor with the exposure time (shutter speed) and lens opening diameter (aperture).[15] In addition to affecting the amount of light that enters the camera, the aperture also affects the amount of the scene that appears to be in focus. When a small diameter aperture is used, a larger portion of the scene in front and behind the actual focal point appear to be in focus as well.[13] Camera systems that are capable of manual aperture settings to maximize the zone of focus are ideal for dental documentation purposes. Supplemental light is supplied by a dual-point strobe flash is best for intraoral

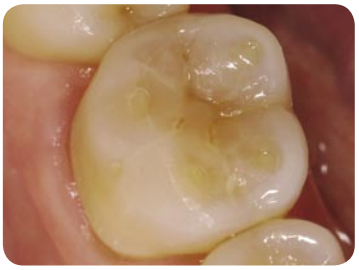

FIGURE 10. This same tooth, as in Figure 9, but the image was captured with a DSLR. The pixel dimensions of the 2592 x 1885 after cropping to match the perspective of Figure 9. Note the even illumination, lack of pixelation, and improved color representation.

FIGURE 11. Laboratory shade images should have a shade tab in the same plane as the documented tooth. Beyond hue and chroma, photographs are the most effective means to communicate nuances in translucency, texture, incisal effects, and contour.

FIGURE 12. Black and white (gray scale) images aid in evaluation of value without the unwanted misinterpretations that can be caused by adjacent colors. Some DSLRs are capable of b/w capture, but color pictures can also be converted to gray scale with computer software.

FIGURE 13. Maxillary anterior dentition with mild diastemas prior to treatment (a) and with diastema closure after conservative direct resin restorations (b). Tooth proportions were improved simultaneously with the alteration in tooth contour.

purposes. A twin-flash design may offer the best combination of soft, uniform illumination while simultaneously revealing surface detail, color transitions, translucency variations, and crack lines.[15]

The applications for digital intraoral photography have greatly enhanced the documentation of clinical evaluation. Photographic images are indispensable for the documentation of pretreatment conditions, clinical treatment steps, and post-treatment results. Patients are often motivated to enroll in dental treatment through co-diagnosis with preoperative digital images.[16,17] Clinicians can utilize photographs of treatment performed for other patients to provide an example of specific procedures and the results they can achieve.[18,19] Photographic images augment both oral and written clarification in presenting informed consent prior to commencing treatment.[17,18,20,21] Additionally, visualization of potential treatment results can stimulate patient involvement that develops the relationship between the clinician and patient.[22,23]

During delivery of esthetic dental treatment, color photographs are indispensable in communicating shade nuances to laboratory technicians.[24,25] The images communicate the color of surrounding dentition as well as underlying preparations. Proportions and positions of enamel tints, characterization intensities, degree of translucency, depth of opacity, and incisal edge can be adequately captured (**FIGURE 11**). Black and white photographic images can provide a visual description of surface texture, as well as an objective measure of tooth value (reflectivity)[26] (**FIGURE 12**).

Since laboratory technicians fabricate restorations with stone models, photographic images of provisional restorations are imperative to visualize dental proportions in relationship to surrounding soft tissues.[27] Photographs enable technicians to evaluate smile line harmony, horizontal occlusal plane orientation, and white/black/pink space proportions revealed in a full smile. Photographs of lips in repose show the incisal edge display at rest.[28,29] Photographic images of postoperative results can provide feedback for self-assessment to each member of the restorative team for the opportunity to learn and improve future results.[30] Digital images of pre-existing clinical conditions can validate and verify the need for treatment delivery when submitting insurance claims.[19]

Restorative Alternative Perspectives

The clinician must deliver care that satisfies the patient subjectively and the clinician objectively. To be successful, the treatment must meet or exceed patient expectations. As a dentist considers the wide array of possible esthetic treatment recommendations for their patients, the choices can seem daunting. Just because a treatment modality is possible, it may not be predictable — or even advisable. The best dental treatment recommendations and subsequent dental care delivery decisions are evidence-based, relying on sound clinical research to formulate treatment protocol.[31]

Advances in adhesive dental technology have allowed clinicians to consider and deliver esthetic treatment modalities that were previously not possible. Direct resin restorations provide a plethora of predictable treatment possibilities for minor alterations in tooth contour or color with minimal preparation.[32,33] (**FIGURE 13**). Stacked powder-liquid ceramics offer additional improvement in surface durability and color stability through indirect fabrication. Since these conservative restorations can be fabricated with thin labiolingual dimensions, they require minimal tooth reduction and afford maximum enamel preservation. By bonding directly to enamel, the adhesive interface is durable, predictable, and maximized.[34,35] Delivery of these cosmetic services requires sig-

FIGURE 14. Maxillary dentition undergoing treatment for large diastema closure with preparations designed to maximize enamel retention and enamel margins (a) and after cementation of pressed ceramic restorations (b).

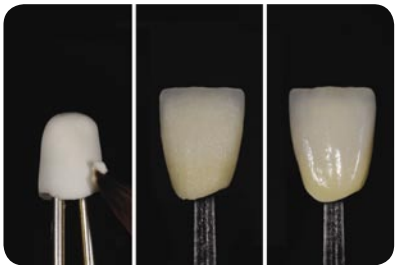

FIGURE 15. Laboratory fabrication of a zirconia-core crown. Fluorescent masking layer to applied to the white zirconia coping (a) is undetectable within the body build-up with porcelain margin, dentin layers and incisal window (b), or the completed crown (c).

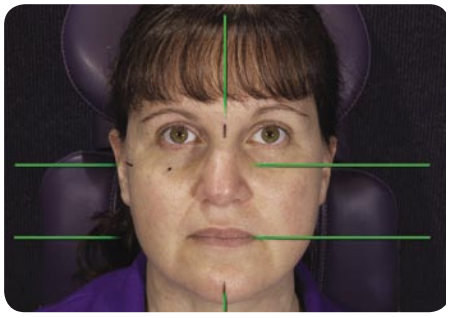

FIGURE 16. The Frankfurt horizontal and interpupillary midline are recognizable landmarks that can be utilized to create an alignment grid to capture images with repeatable, diagnostic angulation.

nificant skill. Ceramic construction with liquid-powder systems requires the use of refractory dies or twin foil techniques. Considerable experience is required of the laboratory technician.[36] Furthermore, clinical circumstances don't always meet the ideal criteria required for placement of conservative esthetic restorations. Broken teeth, missing enamel, and parafunctional habits all present challenges that render the long-term outlook for conservative cosmetic restorations questionable.[37-42]

Ceramo-metal restorations were previously the only viable restorative option if additional strength was needed for clinical durability by virtue of the support of their metallic inner core. While the restorations have proven to be predictable, they have two significant liabilities.[43] The metallic core is both dark and opaque. The esthetic consequences are problematic. The core casts a shadow that prevents light transmission into the root.[44,45] The overlying gingiva can appear objectionably dark. The color of the core material has to be optically masked. The preparation dimensions must necessarily be deep to allow room for masking techniques and materials. Even with an aggressive preparation design and subgingival margin placement, significant technical skill is required to mask the core without creating an opaque appearance that is readily detectable.[46] Since ceramo-metal restorations were traditionally cemented, a circumferential preparation was mandatory, and retention was determined by the length and parallelism of the opposing axial walls.[47]

Pressed ceramic systems were developed as an esthetic restorative alternative to overcome some of these obstacles. Pressed ceramic restorations provide enhanced cohesive strength to expand the amount of unsupported restorative material that can augment the contours of teeth without the need for a metal core.[48-50] This restorative strategy presents many advantages. By eliminating the internal metal coping, excessive opacity is reduced, and improved optical properties are more readily achieved.[51] The ability to etch the ceramic interface allows adhesion for restoration retention. Preparation design can be more conservative, and partial coverage restorations are possible (**FIGURE 14**). Translucent luting cements allow the placement of supragingival margins. Pressed ceramic fabrication techniques allow the dental laboratory to create ceramic margins with procedures that mimic the lost-wax techniques utilized in cast gold restorations.[52] With familiar fabrication strategies and desirable optical properties, the esthetic treatment modalities could be offered by a wider spectrum of dentists being supported by a larger number of technicians.[53,54]

Unfortunately, the pressed ceramic fabrication process came with limitations of its own. Although more conservative than that required for ceramo-metal restorations, minimum preparation depths were still required by material manufacturers to meet the physical constraints of the material itself.[55] These criteria often result in the complete removal of tooth enamel in all prepared areas.[56,57] Research has shown that tooth flexure increases significantly with the percentage of tooth structure removed.[58,59] Since the ultimate strength of a pressed restoration is directly dependent on the strength of the underlying tooth structure, increased tooth flexure can result in increased ceramic fracture. If pressed ceramics are utilized to create the illusion of improved tooth alignment, the resulting combination of tooth reduction, tooth flexure and occlusal forces may create a combination that could result in restoration failure.[60-62]

More recently, alternative ceramic materials have been developed to replace the metal in strengthened-core porcelain restorative strategies. Alumina and zirconia-based materials provide a densely sintered crystalline structure with physical properties that rival metal-based systems.[63-65] Even though preparation depth requirements are the similar to ceramo-metal restorations, the white ceramic core is somewhat easier to mask.[66,67] (**FIGURE 15**). Laboratory fabrication of the ceramic copings can be outsourced to centralized locations and then returned to the initial lab for completion of contour and shade matching with standard veneering techniques that mimic those used for ceramo-metal fabrication. Through the development of ceramic systems that utilize familiar fabrication strategies and with improved

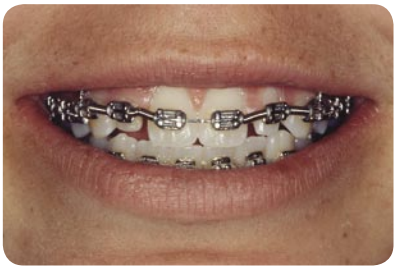

FIGURE 17. A pretreatment photograph of the full smile of a patient at the initial evaluation appointment utilizing the Frankfurt horizontal and interpupillary midline as alignment grid landmarks.

FIGURE 18. A pretreatment photograph of a frontal retracted view of the same dentition as Figure 17 utilizing the same alignment guides. Nearly identical alignment allows both images to be superimposed for smile design purposes.

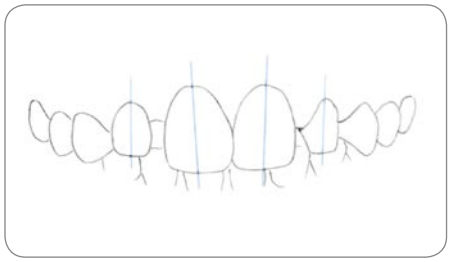

FIGURE 19. The initial tracing of the pretreatment tooth arrangement of Figure 18. A retracted view allows accurate duplication of the gingival frame. Blue lines were added to aid visualization of the existing axial inclination of the incisors.

optical properties, strengthened esthetic treatment modalities can again be offered by a broader range of dentists with supported by a larger number of technicians.

In planning for cosmetic restorative treatment, the clinician must balance the specific needs of the patient with the advantages and disadvantages of each available treatment modality. The clinician must have a method of comparing the pretreatment findings with the desired outcome to choose the alternative on behalf of the patient.

Smile Design

Specific treatment modalities can only be considered after a comprehensive evaluation of facial and dental structures is performed and the desired outcome is previsualized.[3] Assessment for developing esthetic treatment plans begins with excellent intraoral photographic documentation.[14] Different images are required to evaluate the full spectrum of esthetic principles for each patient. A view that captures the entire head of a patient would be required to evaluate facial balance principles (e.g., interpupillary line, midline, occlusal plane, E-plane, nasolabial angle). A view with the lips in repose is useful to assess the incisal edge display at rest. A view with a full smile is required to evaluate dentofacial principles involving the degree of harmony of the lips with the underlying dental structures (e.g., convex smile line, gingival display, buccal corridors). Finally, a retracted view with lips pulled out of the way is needed to assess gingival frame principles and individual tooth characterization (e.g., gingival emergence pattern, maxillary tooth proportions, axial inclination gradation, polychromatic tooth gradation).

By utilizing repeatable facial landmarks as a guide for camera alignment, multiple images can be captured with identical alignment in photography, even if they are taken for different purposes (i.e., full smile versus retracted) or on different days (i.e., pretreatment versus post-treatment). It has been suggested that the Frankfurt horizontal and the interpupillary midline are examples of convenient, unchanging landmarks that can be utilized for consistency in dental photography[68] (**FIGURE 16**). Tracings of images with identical alignment can be superimposed to allow the simultaneous evaluation of all esthetic principles, with or without the lips in place (**FIGURES 17-18**).

The initial tracing of the maxillary teeth, as seen in a retracted view, provides the basis for evaluating the position of teeth at the time of the examination (**FIGURE 19**). A second piece of tracing paper is placed over the first for the development of a smile design framework that incorporates the aforementioned esthetic principles. Vertical lines representing frontal height of contour of the maxillary canines are drawn to define the maxillary canine-canine width. The distance is divided in half and marked with a third vertical line representing the proposed dental midline. The remainder of the maxillary anterior segment is divided with vertical lines that correspond to 22 percent, 16 percent, and 12 percent of the total canine-canine width. These width relationships reflect the ideal proportions of a modified Golden Percentage analysis.

The width of the central incisor is divided by 0.75 to determine the height needed for a width:height ratio of 75 percent. The calculated height for the central incisor is used to position a gingival guideline in harmony with the upper lip reveal and a smile line in harmony with the curvature of the lower lip. The gingival framework may be drawn as a straight horizontal line, only if the initial photograph capture was aligned with the Frankfurt horizontal landmarks. Mesial axial inclination guidelines and embrasure depth guides are added in contrasting colors to complete the framework (**FIGURE 20**).

Another piece of tracing paper is superimposed over the outline of the existing teeth and the ideal smile framework. Each tooth of the anterior segment is added in its position within the designed tooth arrangement. By conforming to the boundaries and guidelines of the framework dimensions, the proposed smile design will simultaneously possess all of the desired dentofacial principles. The clinician can then compare the difference between the underlying tracing of the existing tooth arrangement with the proposed tooth arrangement of the superimposed smile design (**FIGURE 21**).

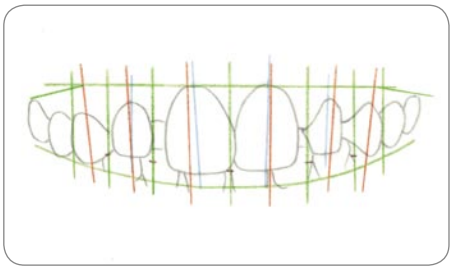

FIGURE 20. A design framework is superimposed over the original tracing. It represents guidelines for anterior tooth proportions, angulations, embrasures, and gingival emergence as dictated by the canine-canine width and lip reveal of the individual patient.

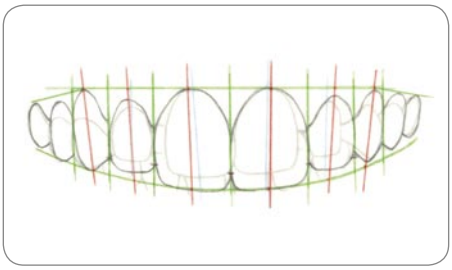

FIGURE 21. A proposed smile design is developed and superimposed to conform to the dentofacial principles of the completed framework. Disparities suggest treatment alternatives (e.g., additional orthodontics, posterior segment crown lengthening, anterior veneers).

FIGURE 22. A pretreatment retracted view reveals arrangement deficiencies (including missing lateral incisors) that contribute to a canted smile line, inappropriate anterior proportions, embrasure irregularities, and gingival pattern violations.

Application and Implementation

Some esthetic dental problems are related to dental principle violations in color or contour. Tooth wear, for example, could detract from the proper appearance of tooth form while excessive intrinsic chroma might adversely affect the polychromatic shade shift within a tooth. Often dental principle issues can be addressed with conservative treatment options. Occasionally, tooth characterization difficulties can be addressed on a limited or even isolated basis.

Dentofacial principles violations, however, are more complex since tooth arrangement factors are always the cause and since improvement in tooth alignment is the logical treatment of choice (**FIGURE 22**). Orthodontic treatment is often the only treatment alternative that ultimately can produce an ideal result in dentofacial relationships.[70] With the advent of elective esthetic treatment, however, patient expectations regarding treatment options can be misunderstood or even unrealistic. Patients may look to restorative treatment modalities to avoid the traditional alternatives that would predictably achieve the results they desire.[69] While patients may prefer to explore restorative alternatives with accompanying periodontal crown lengthening surgery, continued smile principle violations (e.g., in width proportions, embrasure gradation, gingival emergence pattern and symmetry) are inevitable if the underlying root positions remain unchanged (**FIGURE 23**). The dental team must have a method to help the patient consider the array of available treatment alternatives.

Beyond the use of photographic images alone, the creation of a smile design offers many powerful and effective communication opportunities for the dental team during the treatment consultation process. As the clinician draws the design, the patient directly observes the artistic ability and expertise of the dentist. This may prove beneficial in enhancing patient confidence or in helping a patient choose from among several possible offices for receiving esthetic care. Beyond merely boosting credibility for the dental team, however, the patient can easily visualize the disparity between the existing tooth arrangement and that of a design that conforms to accepted esthetic principles. The smile design allows the dentist to correlate objective clinical findings with the patient's stated priorities. At issue is the eventual determination of a treatment plan that will meet the patient's subjective expectations.

The doctor and patient can now collaborate as they assess the feasibility of achieving the proposed goals. With the help of the smile design, they can consider the esthetic problems caused by the dentofacial relationships (**FIGURE 24**). Periodontal procedures and orthodontic treatment should be considered as important supplements or even replacements to restorative care alone. An interdisciplinary approach is often required to achieve all the patient's expectations.[70] The more comprehensive the treatment plan, the more inclusive the application and achievement of esthetic principles in the delivery of care for complex cases (**FIGURE 25**).

If the patient chooses to limit treatment, however, it is essential for the clinician to present the predictable limitations in the results. If a patient with dental malalignment prefers restorative treatment alone to achieve the illusion of proper alignment, compromises in color, contour, emergence, and symmetry may remain unresolved as lingering esthetic liabilities. Additionally, patients may impair expected treatment results by insisting on the utilization of specific restorative materials. Many patients demand metal-free restorative solutions, and clinicians may be tempted to encourage their exclusive use.[71] The marketing tactics of some restorative material manufacturers may inappropriately persuade dental consumers to believe that one specific material or fabrication technique is applicable and preferable for all clinical circumstances. Unfortunately, patients may still hold the clinician responsible for any restorative failures in spite of the constraints that they imposed during treatment planning. Realizing what cannot be accomplished with a specific treatment option is just as important as understanding what can be achieved.

The smile design process represents

FIGURE 23. A post-treatment view of the same patient as Figure 22. Although restoration contours created the illusion of many esthetic improvements, the patient's refusal of comprehensive orthodontic and periodontal treatment resulted in persistent esthetic violations.

FIGURE 24. A preprosthetic view of the same patient as Figures 17-21. The patient agreed to additional orthodontics and posterior crown lengthening to position the teeth and gingiva appropriately to develop ideal anterior principles of proportion and alignment.

FIGURE 25. A post-treatment view of the completed case for the patient in Figures 17-21 and 24.

a tool to overcome these obstacles. In addition to objectively identifying the number of teeth that present esthetic distraction, it can indicate appropriate preparation design strategies that in turn require specific material selection recommendations. If tooth alignment is already ideal, facial surface preparation alone with maximum enamel retention may suffice. In that circumstance, direct resin restorations or powder-liquid ceramic veneers allow the most conservative treatment solution. If anterior width proportions are to be altered, additional interproximal preparation will be required, and significantly more enamel will be removed. In the case of traumatic fractures, significant enamel may already be missing. In the face of these increased restorative demands, pressed ceramic systems should be considered as a strengthened partial coverage alternative.

Although pressed ceramics allow partial coverage preparation design, occlusal function, and resulting flexural forces must be respected. Parafunction, abfraction, sclerotic dentin are all complicating factors. To establish anterior guidance, increase strength, and enhance predictability, full coverage preparations and ceramic modalities with internal strengthened cores may be indicated. Rather than inappropriately selecting a restorative material and then attempting to apply it to a patient's needs, the clinician can use the smile design to appropriately assess the patient's needs first and then select the restorative material that specifically meets those needs.[3] With a treatment planning paradigm driven by design, a dentist aptly may recommend and prescribe different restorative materials on a tooth-by-tooth basis. The dentist must then select a laboratory with the capability and experience to effectively utilize the required material systems.

Precise dimensional changes for periodontal, orthodontic, and laboratory procedures can be quantified, illustrated, and transferred to models, guides, and restorations. The prospect for predictable, coordinated treatment result is thus increased.

Conclusion

The contemporary photographic process is revolutionizing the way clinicians diagnose, treat, and communicate with patients and colleagues. Smile design techniques expand the use of photography to analyze existing esthetic problems and communicate possible treatment alternatives. Treatment acceptance occurs when patients perceive the recommended treatment will resolve current and future concerns for a fee that is commensurate with the benefits they gain. Patient satisfaction is achieved when the clinician meets or exceeds the patient's expectations. It is only through a balance in objective diagnosis, effective communication, and evidence-based planning that proper recommendations can be made for the delivery of excellence in cosmetic dental treatment. ■■■■

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TO REQUEST A PRINTED COPY OF THIS ARTICLE, PLEASE CONTACT Stephen R. Snow, DDS, Snow Dental Care, 909 San Ramon Valley Blvd., #216, Danville, CA 94526.