Macroesthetic elements of smile design

JEFF MORLEY, D.D.S.; JIMMY EUBANK, D.D.S.

ABSTRACT

Background. Clinicians' expanding use of cosmetic restorative procedures has generated greater interest in the determination of esthetic guidelines and standards. The overall esthetic impact of a smile can be divided into four specific areas: gingival esthetics, facial esthetics, microesthetics and macroesthetics. In this article, the authors focus on the principles of macroesthetics, which represents the relationships and ratios of relating multiple teeth to each other, to soft tissue and to facial characteristics.

Case Description. The authors categorize macroesthetic criteria based on two reference points: the facial midline and the amount and position of tooth reveal. The facial midline is a critical reference position for determining multiple design criteria. The amount and position of tooth reveal in various views and lip configurations also provide valuable guidelines in determining esthetic tooth positions and relationships.

Clinical Implications. Esthetics is an inherently subjective discipline. By understanding and applying simple esthetic rules, tools and strategies, dentists have a basis for evaluating natural dentitions and the results of cosmetic restorative procedures. Macroesthetic components of teeth and their relationship to each other can be influenced to produce more natural and esthetically pleasing restorative care.

The dental profession has long been in pursuit of the ideal dentition. Recent advances in conservative restorative procedures, such as bonding and porcelain veneers, have opened the door to a wide variety of elective dental treatments for the purpose of enhancing appearance or reversing the visual signs of aging.[1,2] However, the newfound popularity of cosmetic dentistry has only intensified the profession's long-standing desire to replicate nature when restorative dentistry is indicated.

In an effort to create natural esthetics, the clinician must give careful consideration to the patient in his or her entirety. Individual attributes of a tooth may represent only part of the story, because teeth do not exist individually and separate from the patient to whom they belong. Combinations of tooth forms when positioned together can create an effect that is greater than, equal to or less than the sum of the parts.[3]

The cumulative visual impact of the anterior dentition often transcends the sum of the individual parts.

The popularity and increasing predictability of recently developed restorative techniques such as porcelain veneers have created new demands on practitioners. While any type of tooth restoration can be done as a single unit or in multiples, the cumulative visual impact of the anterior dentition often transcends the sum of the individual parts.

The principles involved in making "pretty smiles" have come to be known within the profession as the discipline of smile design. Smile design theory can be broken down into at least four parts: facial esthetics, gingival esthetics, microesthetics and macroesthetics.

- Facial and muscular considerations vary from patient to patient and are worthy criteria for evaluation. Photographic analysis can determine how the lips and soft tissue frame the smile in different positions of speech, smiling and laughter.
- Esthetic conditions related to gingival health and appearance are an essential component of effective smile design. Inflamed, uneven gingival lines detract from a pleasing smile. Blunted papilla and asymmetric gingival crests become part of the overall esthetic picture.
- Microesthetics involves the elements that make teeth actually look like teeth. The anatomy of natural anterior teeth is specific for each tooth and that tooth's location in the dental arch. Specific incisal translucency patterns, characterization, lobe development

Figure 1. Restoration of anterior dentition in which restoration design lacks apparent harmony with surrounding soft tissue.

Figure 2. Re-treatment of dentition in Figure 1 using macroesthetic design principles to better blend in with and complement surrounding soft tissue.

and incisal haloing all are components of the microesthetics of each tooth. Dentists and technicians alike endeavor to replicate the microesthetics of teeth in restorations.

Macroesthetics, the fourth of these aspects and the focus of this article, represents the principles that apply when groupings of individual teeth are considered.[4] The relationship between those teeth and the surrounding soft tissue and the patient's facial characteristics creates a dynamic and three-dimensional canvas. The artistic work of the dentist and the technician can combine to create a natural and pleasing overall appearance—or not—depending on how well the relative shapes, sizes and arrangement of the individual teeth harmonize with the features of any given patient (Figures 1 and 2).

Careful photographic analysis of patients' faces shows that prominent facial anatomy can be deceptive in locating the facial midline.

Macroesthetics attempts to identify and analyze the relationships and ratios between anterior teeth and surrounding tissue landmarks. In this article, we discuss the principles of macroesthetics and how to apply them.

MACROESTHETIC DESIGN ELEMENTS: FACIAL MIDLINE

In smile design, the starting point of the esthetic treatment plan is the facial midline.[5] When viewing dentitions, many clinicians use the maxillary central incisors as their esthetic baseline and then move laterally in a progression from the lateral incisors to the canines to the premolars and beyond. However, considering the importance of the facial midline, there remains confusion regarding techniques for reliably locating it.[6] Careful photographic analysis of patients' faces shows that prominent facial anatomy—including the eyes, nose and chin—can be deceptive in locating the midline. Most people's eyes are at slightly different levels or at different depths within the sockets. Many patients have noses or chins that deviate from the center, which undermines these landmarks as indicators of the facial midline.[7]

A practical approach to locating the facial midline references two anatomical landmarks. The first is a point between the brows known as the nasion. The second is the base of the philtrum, also referred to as the cupid's bow in the center of the upper lip. A line drawn between these landmarks not only locates the position of the facial midline but also determines the direction of the midline (Figure 3).

Whenever possible, the midline between the maxillary central incisors should be coincidental with the facial midline. In cases in which this is not possible, the midline between the central incisors should be parallel to the facial midline.[8-10] If the visual junction of maxillary central incisors is at an angle to the facial midline, it is referred to as a canted midline. Canting is a major design flaw in any natural or restored dentition. While alignment of the maxillary and mandibular dental midlines is desirable in orthodontics, the mandibular midline becomes a lesser issue in esthetics.[11] The narrowness and uniform sizes of mandibular incisors make visualization of their middle point more difficult, particularly when

Figure 3. Plotting the facial midline using nasion and cupid's bow as reference points.

Figure 5. Unrestored dentition exhibiting the 50-40-30 relationship of interproximal connectors between the central incisor, the lateral incisor and the canine.

seen in relationship to lips and other soft-tissue landmarks.

Incisal embrasures. The pattern of silhouetting created by the edges and separations between the maxillary anterior teeth against the darker background of the mouth helps define a good-looking smile. These spaces between the edges of the teeth known as embrasure spaces follow a pattern that develops between the central incisors and then progress laterally. The size and volume of the incisal embrasures between teeth increase as the dentition progresses away from the midline[12] (Figure 4). In other words, the incisal embrasure space between the lateral incisor and the central incisor should be larger than the incisal embrasure between the central incisors. The embrasure between the canine and the lateral incisor should be larger than the embrasure between the lateral and central incisors.

Figure 4. Cosmetic restoration of dentition showing progressive increase of incisal embrasure size from central incisor to lateral incisor to canine.

Connectors. The places in which the anterior teeth appear to touch has been referred to as the connector space. There is a distinction between a connector space and a contact point. The contact points between the anterior teeth are generally smaller areas (about 2×2 millimeters) that can be marked by passing articulating ribbon between the teeth. The connector is a larger, broader area that can be defined as the zone in which two adjacent teeth appear to touch. An esthetic relationship exists between the anterior teeth that is referred to as the 50-40-30 rule.[13] This rule defines the ideal connector zone between the maxillary central incisors as 50 percent of the length of the central incisors. The ideal connector zone between a maxillary lateral incisor and a central incisor would be 40 percent of the length of the central incisor. The optimum connector zone between a maxillary canine and a lateral incisor when seen in lateral view would approximate 30 percent of the length of the central incisor (Figure 5).

Axial inclinations. Each combination of tooth inclinations in a smile is unique. The long axis of, or direction of the anterior teeth in, an esthetic smile also follows a progression as the teeth move away from the midline. If the long axis of the tooth tips toward the midline when assessed from the height of the gingival margin toward the incisal edge, the tipping is medial. Conversely, if the long axis of the tooth seems to move away from the midline, the tooth is said to tip laterally or buccally. When the maxillary anterior teeth tip medially, the overall esthetic impact is one of a harmonious relationship with the framing of the lower lip.[14] As in many of the macroesthetic rules

Figure 6. Progressive medial tipping of the axial inclinations of the anterior teeth.

of progression, the medial tipping of the axial inclinations increases as one moves further from the midline (Figure 6).

Shade progression. Even the shade and color patterns of the maxillary teeth follow a progressive pattern based on the distance from the midline (Figure 7). The maxillary central incisors are the lightest and brightest teeth in the smile.[15] The maxillary lateral incisors have a similar hue to that of the central incisors but are typically just slightly lower in color, or value. The canines have greater chroma saturation and also are lower in value than any of the other anterior teeth. First and second premolars appear lighter and brighter than the canines and have a value similar to that of the lateral incisors.[15] Reproduction of shade progression in anterior restorative and cosmetic treatment re-creates a look that approximates natural esthetics even when patients seek the very lightest shades.

Even the most beautiful anterior teeth have little esthetic value if the amount of tooth reveal is unflattering to the face.

MACROESTHETIC DESIGN ELEMENTS: TOOTH REVEAL

"Tooth reveal" is a term for the amount of tooth structure or gingiva that shows in various views and lip positions. Even the most beautiful anterior tooth or teeth will have little esthetic value for the patient if the amount of reveal is unflattering to the face. By standardizing maximum and minimum lip parameters based on muscular and phonetic positions, the clinician can quantify esthetic ratios and relationships of tooth reveal. These various ratios, while somewhat anecdotal, can assist the dentist when analyzing esthetics in day-to-day practice while at the same time providing valuable guidelines in the cosmetic restoration of natural dentitions. In many cases, cosmetic treatment can involve a determination of tooth length and positioning of the incisal edges of the anterior teeth. Esthetic reveal positions are a strategic treatment-planning tool when taken into consideration with occlusal and phonetic guidelines.

"M" position. By having the patient say the letter "M" repetitively and then allow his or her lips to part gently, the clinician can assess minimum tooth reveal (Figure 8). The amount of maxillary or mandibular teeth that show in this position has been demonstrated to be different at different stages of life. While younger patients may show between 2 and 4 mm of maxillary incisal edge in this position, the maxillary incisal edge reveal shrinks and even disappears as people age.[17] In some elderly patients, the mandibular incisal edges begin to show. Carefully locating the "M" position reveal and creating the restoration accordingly can have the fluid effect of making a smile age-specific, being either younger or older in appearance.

"E" position. When patients say the letter "E" in an uninhibited and exaggerated way, the clinician can ascertain the maximum extension of the lips (Figure 9). While patients commonly say they do not normally smile in this position, the reveal exhibited reaches the maximum position achievable under extreme conditions. During photographic analysis of the smile, everything that shows can be considered to be in the esthetic zone.[17] Restorative, surgical and periodontal treatment within the esthetic zone should take into consideration both the cosmetic and the health consequences of the result. While health never should be sacrificed for appearance alone, neither should the patient's appearance be sacrificed for convenience or through the clinician's failure to consider all of the esthetic options.[18]

Intercommissure line and lower lip framing. When a patient's mouth is in broad smile position, the clinician can draw an imaginary line through the corners of the mouth. This line is known as the intercommissure line, or ICL (Figure 10). The amount of maxillary tooth reveal below the ICL interacts with the viewer's perception of the patient's age. In a youthful

Figure 7. Unrestored dentition showing shade progression from central incisor to canine.

Figure 8. Reveal of the incisal edges of the maxillary incisors in the "M" position.

Figure 9. Reveal of the anterior dentition in the "E" position.

Figure 10. The intercommissure line and reveal of the maxillary anterior teeth can be useful in developing an esthetically pleasing smile.

smile, approximately 75 percent to 100 percent of the maxillary teeth would show below this line.[2] The position of the incisal edges of the anterior teeth as they relate to the lower lip also may have esthetic consequences. When the visual space created between upper and lower lips in full smile is considered, the maxillary anterior teeth should fill between 75 percent to 100 percent of that space to create a youthful look.[19]

Vestibular space. In a broad smile, the amount of reveal of the maxillary posterior teeth also can become an esthetic consideration. In patients who have narrow arch form and wide lip extension, tooth reveal behind the canines can be in shadow or disappear completely (Figure 11). This condition has been called deficient vestibular reveal, or DVR.[20] DVR may have negative esthetic consequences in certain patients.

Smile line. The plane of the incisal edges of the maxillary anterior teeth also can be related to the two fundamental criteria of midline and reveal. Traditional orientation of the smile line calls for it to be parallel with a line drawn between the pupils of the eyes.[21] Unfortunately, this guideline does not accommodate situations in which patients have eyes in different planes (Figure 12). Creation of an incisal plane that is perpendicular to the facial midline produces a reliable and repeatable position that does not depend on the interpupillary line.[22]

Once the clinician has determined the orientation of the smile line, he or she can design its curve, or shape. When the incisal edges of the maxillary central incisors appear to be below the tips of the canines, the smile line has a convex appearance that can approximate and harmonize with the line of the lower lip[23] (Figure 13). A so-called "reverse smile line" results when the tips of the canines or premolars are longer than those of the central incisors. This design condition does

Figure 11. Teeth in shadow distal to the maxillary canine can contribute to deficient vestibular reveal.

Figure 13. Convex arch of anterior teeth in which the incisal edges of central incisors are visibly lower than the tips of the canines.

not harmonize well with other facial features and also may be associated with occlusal malfunction or loss of vertical dimension.

CONCLUSION

The cumulative visual impact of the smile cannot be associated exclusively with the beauty of individual teeth. The microesthetics of natural and restored dentitions must be combined with macroesthetic considerations, of which we have presented only a partial list. Smile design is a relatively new discipline in the area of cosmetic dentistry, and it involves several areas of evaluation and treatment planning. As mentioned earlier, macroesthetic principles are only part of the overall picture; gingival esthetics, facial esthetics and microesthetics are the other three essential components of effective smile design. In addition, occlusal and engineering issues also may alter the

Figure 12. Asymmetrical facial features, including eyes in different planes, are not useful reference points in determining the smile line.

smile design in both natural and restored dentitions and could influence the longevity of cosmetic treatment.

It should not be forgotten that each patient is unique, representing a special blend of age characteristics and expectations, as well as sex and personality specificity. Macroesthetic concepts provide only guidelines and reference points for beginning esthetic evaluation, treatment planning and subsequent treatment. The artistic component of dentistry—and particularly of cosmetic dentistry—can be applied and perfected by dentists who understand the rules, tools and strategies of smile design. ■

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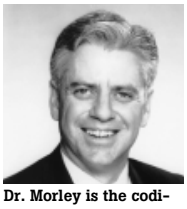

Dr. Morley is the codirector of advanced restorative esthetics postgraduate programs at Louisiana State University, New Orleans; University of California at Los Angeles; and University at Buffalo School of Dental Medicine, New York. He maintains a private practice in cosmetic and restorative dentistry in San Francisco. Address reprint requests to Dr. Morley at 1648 Union St., San Francisco, Calif. 94123.

Dr. Eubank is the codirector of advanced restorative esthetics postgraduate programs at Louisiana State University, New Orleans; University of California at Los Angeles; and University at Buffalo School of Dental Medicine, New York. He maintains a private practice in cosmetic and restorative dentistry in Plano, Texas.

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