

inside ESTHETICS

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Smile Analysis and Esthetic Design: “In the Zone”

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Increasingly, patients seeking treatment present with the primary concern of an esthetic enhancement to their oral condition. Many articles have been written and courses taught over the years on concepts of smile design to develop a treatment plan to get an esthetic outcome for the patient.¹⁻⁷ Esthetic or cosmetic dentistry has become one of the main areas of dental practice emphasis and growth for several years. These terms (ie, esthetic and cosmetic) have almost become synonymous in our dental nomenclature. The literal definitions of these terms are very different. Cosmetic means to do “something superficial to cover a defect or deficiency” and secondarily “serving to beautify the body.” The second part of this definition has a very large cultural component to this, ie, beauty is in the eye of the beholder. There is also an implication that something “cosmetic,” while deemed “beautiful,” is obvious to the observer that a facial or dental characteristic has been enhanced—eg, using make-up to accentuate a facial feature. According to the Merriam-Webster dictionary, the definition of esthetics, on the other hand, is “responsive to or appreciative of what is pleasurable to the senses” or “pleasing in appearance.” Thus, cosmetics and esthetics are somewhat inseparably intertwined, but esthetics also encompasses appearances that do not have a “cosmetic appearance.”

Timeless human esthetics implies a sense of beauty, a pleasing impulse, naturalness, and a youthful appearance relative to one’s age. The goal for esthetic treat-

ment should be an enhanced but natural appearance that imparts a vibrant and believable appearance to the patient. This should be our goal in dental esthetics: a result that would be considered “bright, beautiful, but believable.” This may entail the use of cosmetic procedures as already stated but, just as importantly, it blends the functional and biologic requirements of the patient into a durable and long-lasting result. The treatment should be as conservative as possible and allow the patient future options as new technologies are developed.

This article will focus on historically accepted smile design concepts and present research of smile parameters that will help the reader to design their esthetic treatments. It is very important to note that smile design concepts have been presented in a very static manner, ie, specific measurements for form, color, and position of esthetic dental elements. This is fine for basic information transfer of smile design principles, but it is critical to understand the esthetics is not a finite point; in fact, esthetics can be a broad zone. We like to refer to this as “the esthetic zone” for a given patient. Thus, we will give from our evaluations what we believe are zones or “ranges” of esthetic values for smile design.

THE PROCESS OF SMILE DESIGN AND ANALYSIS

Smile design should involve the evaluation of certain elements in a specific sequence; (1) facial analysis (general facial balance), (2) dento-facial analysis (maxillo-mandibular relationships to the face, and the dental midline relationship to the face) (3) dento-labial analysis (the relationship

of the teeth to the lips), (4) dento-gingival analysis (the relationship of the teeth to the gingiva, and (5) dental analysis (the intertooth and intratooth relationships, ie, form and position along with color). Even though there is a specific sequence recommended it must be understood that all of the elements are interrelated; changing one will have an impact on all the others.

The concept of the evaluation sequence is based starting with a macro view of the patient and progressively working down to a micro view, ie, looking at the face first and then progressing to evaluate the individual teeth last. The recommended sequence does not necessarily imply the order of importance (even though macro view esthetics is noticed by observers before micro views); it is just a way to systematically evaluate a patient. And the very last thing planned is what material should be used consistent with satisfying all treatment planning goals. The treatment sequence may change and follow an entirely different course depending on these variables. If the treatment plan follows a proper sequence, a restoration would not be planned for a tooth that is malpositioned to the point that it would require mutilation to reposition it restoratively. The treatment plan would reposition it initially so that the tooth is not structurally compromised with excessive preparation.

FACIAL AND DENTO-FACIAL ANALYSIS

The smile analysis evaluation should begin with the observation of the facial elements.¹⁻¹¹ There are guidelines to facial

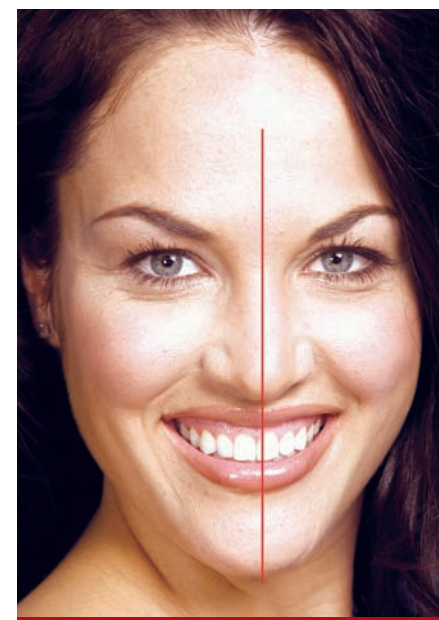


Figure 1 Image of smile where the facial and dental midline do not line up.

form and balance that can be affected by dental treatment. Regardless of how attractive the teeth appear, if they do not relate to the facial structures spatially, the result will be unesthetic. Because of the space limitations of this article, the topics of facial analysis and dento-facial analysis (other than the topic of midline) will not be covered. The reader is referred to many references on facial analysis and its impact on smile design and treatment.²⁻¹² Suffice it to say that obvious facial abnormalities, especially when observing the lower one third of the face, should be referred for orthodontic and orthognathic consultation.

Midline

Ideally, the dental midline should end up collinear with the facial midline but usually it does not (Figure 1). Fortunately, in our experience of all the esthetic parameters, dental midline abnormalities are the least noticed by patients and dental personnel. In one study by Kokich,¹³ it was shown that the public could not tell that dental midlines were off facial midlines of up to 4 mm. As long as the midline is parallel with the long axis of the face, midline discrepancies of up to 4 mm will generally not be perceived as unesthetic. Slight corrections of midlines can be accomplished with restorative dentistry as long as the maxillary centrals are made relatively symmetric and correct intertooth relationships are maintained. If the individual teeth do not require restoration and there is a large midline discrepancy, the ideal treatment is orthodontics.



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Figure 2 Image of the lower one third showing tooth display at rest. The display was measured to be between 2.5 to 3 mm.



Figure 3 Lower one third smiling image showing the relationship of the incisal edge to the lower lip during smiling.



Figure 4 Image showing the smile line with a gull-wing effect.



Figure 5 Image showing excessive (too much negative space) buccal corridor problem, which can be related to a narrow arch form.

DENTO-LABIAL ANALYSIS

The next step in the esthetic analysis is to evaluate the relationship of the lips to the teeth, ie, visual tooth display both statically and dynamically, then buccal corridor (which is related to arch form).

Incisal Edge Position

Published reports have shown that the average 30-year-old woman displays about 3.5 mm of maxillary central incisor tooth structure when the lips are at rest (Figure 2).^{11,14,15} The prosthodontic literature has generally recommended setting denture teeth so that 2 mm of tooth structure is displayed at rest.^{14,16} In the author's experience, the 2 mm exposed at rest is generally less than desired by esthetically driven patients. Also, in the authors' experience, for most patients who have improved esthetics as their primary treatment goal, between 3 mm and 4 mm displayed at rest will be esthetically ideal. Another guide for evaluating the esthetic position of the maxillary anterior incisal edges applies when the patient smiles; in an esthetic composition, the tips of the maxillary anterior teeth come very close to touch the lower lip up to a maximum of 3 mm away (Figure 3).

The esthetic treatment would be to reposition the incisal edges of the maxillary anterior teeth within these two dento-labial esthetic zones. The modality of treatment would be determined in conjunction with the evaluation of all the other smile design and treatment goal parameters. If patients display less than 4 mm of the maxillary central at rest and the teeth need to be lengthened, the length will generally be achieved by adding to the incisal edge.

Incisal Display During Smiling

Tooth size and position, lip length, and lip mobility greatly affect maxillary tooth display both statically and dynamically. The average lip length has been measured at between 20 mm to 24 mm measured from the base of the nose to the edge of the upper lip.^{1,8} Average lip mobility in a normal esthetic smile is 7 mm to 8 mm as measured in the UCLA Center for Esthetic Dentistry (CED) study by showing evaluators images of patients' lower one third of their face while smiling. Subjects who were rated to have a good to excel-

lent smile were measured for an average of 7 mm to 8 mm of lip movement. Also during smiling, all of the maxillary anterior teeth are displayed, from incisal edge to gingival margin (Figure 2 and Figure 3). Most of the maxillary premolars and sometimes the first molar are displayed when smiling. In a study by Kokich,¹³ it was demonstrated that dental evaluators and lay people still considered it esthetic if 2 mm of gingiva showed in a full smile. In our opinion, it is still in the "esthetic zone" to show up to 3 mm of gingiva in a full smile, especially if there is slightly more than 8 mm in lip movement during a smile (Figure 1).

If the incisal display at rest is 3 mm to 4 mm, and it is determined that the teeth are too short, then surgical crown-lengthening procedures should be considered. Two main considerations for surgical crown lengthening are dentin exposure and crown-to-root ratio. The goal is to never expose root structure (dentin) purely for esthetic reasons, especially if bonded porcelain is the ideal restorative option for the patient. If the gingival margin needs to be apically placed for esthetics, and crown lengthening would expose dentin, the ideal option would be to orthodontically or orthognathically move the teeth with the dento-gingival complex applicably to satisfy esthetic requirements. The other obvious consideration is crown-to-root ratio. As a guideline, the primary author will not crown length more than what would create a 60:40 crown-to-root ratio. This option is only considered if gingival dentin is already exposed and crown lengthening is needed to be done anyway for biologic and structural reasons.

If there is insufficient tooth display at rest, normal lip mobility, the teeth are the correct length, and there is inadequate tooth display during smiling, then this is diagnostic of vertical maxillary insufficiency. This is not a case that should be treated with esthetic tooth lengthening. This is an orthognathic problem and should be referred for proper treatment. Conversely, if there is too much tooth display at rest, normal lip mobility, normal tooth length, and an excessive display of gingival during smiling (more than 3 mm) this is diagnostic of vertical maxillary excess.^{15,17,18} This should not be treated by restorative dentistry and surgical crown

lengthening alone; this case should be referred for orthognathic surgical correction. In clinical situations where there is normal tooth display at rest, correct tooth length, correct relationship of the teeth to the lower lip when smiling, and excessive gingival display during smiling, this is usually indicative of excessive lip mobility. This is a very difficult situation to treat, as almost any treatment will leave an esthetic compromise in either a static or dynamic lip position.

Smile Line

In an esthetic smile, the edges of the maxillary anterior teeth follow a convex or gull-wing course matching the curvature of the lower lip (Figure 4), and are generally radially parallel to the horizon. From a frontal view, the maxillary arch from central to molar appears to curve upward, but not always. If it does, this apparent curve may be a result of a slight posterior cant to the maxilla or the frequent appearance of the Curve of Spee in the intact dentition. Slight to moderate devia-



Figure 6 Image of a smile that was rated excellent by several evaluators at the UCLA Center for Esthetic Dentistry.



Figure 7 Image showing the gingival line on the same patient. Note the lateral and central apical position of the gingival margin is on a straight line that is completely horizontal.

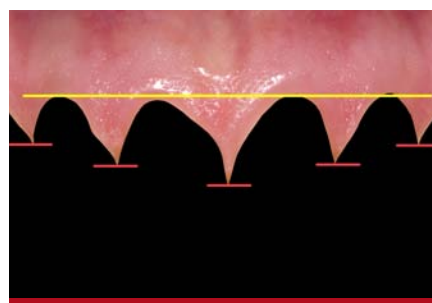


Figure 8 Image demonstrating the measurements of the ideal gingival scallop, with the percentages showing the papilla length relative to tooth length.



Figure 9 Image showing close to an 80% width-to-length ratio and optical width of the central relative to the lateral and the lateral relative to the canine. Note that esthetic percentages do not follow the golden proportion, especially the canine.

tions to this pattern can be effectively treated with esthetic recontouring or conservative restorative dentistry. In situations where there is ideal tooth form and color but there are discrepancies to the smile line or visual tooth display, restorative dentistry is not indicated, as this would cause unnecessary mutilation of otherwise healthy tooth structure. In these clinical situations, and when there is moderate to severe distortion of the smile line, orthodontics would be the more appropriate treatment.

Buccal Corridor

In an esthetic smile there is what has been termed negative space, which is a small space between the maxillary posterior teeth and the inside of the cheek. A broad smile with a minimal buccal corridor is deemed most esthetic by lay people;¹⁹ however, a broad smile without a buccal corridor could also be perceived as fake.²⁰ If the space appears excessive (Figure 5) when the patient is smiling, a small amount of the space can be filled by increasing the buccal



Figure 10 Preoperative image of a case requiring improving esthetic proportions.



Figure 11 Preparations of the same case which shows the significantly pegged lateral that was present under the old composite bonding.



Figure 12 Postoperative image of creating ideal proportions using bonded porcelain restorations.

contours of the maxillary posterior restorations—assuming restorations need to be placed for restorative reasons. If conservative additive or subtractive (ie, esthetic contouring) techniques will not work esthetically, then orthodontics should be considered.

DENTO-GINGIVAL ANALYSIS

The lips frame the teeth and gingiva. The gingiva frames the teeth. The ratio of tooth structure to the amount of gingival and labial tissue should be harmonized to prevent an over-dominance of any one element. As such, establishing proper gingival relationships relative to the lips has been discussed in the previous section. Gingival margin placement is based on lip dynamics, and to a certain extent desired tooth length (which will be discussed in the next section). Other factors to consider in designing esthetic gingival relationships are: gingival line (the relationships of free gingival margins of the maxillary teeth), gingival scalloping and contour, papillary tip positioning, and gingival color.

Gingival Line

There have been several gingival reference line relationships that exist from maxillary bicuspid to the contralateral bicuspid that have been discussed as being esthetic.²¹ Other than the dental midline, slight discrepancies in the gingival line are least noticed by the public or by dental professionals. The key esthetic issue is that the gingival line for the anterior teeth should be relatively horizontal to the horizon and relatively symmetric on both sides of the midline. It may radiate up slightly as it goes posterior. It is not critical that the lateral incisor gingival line fall incisal to the central as this is not obvious when a person is smiling (Figure 6). Positioning the lateral to the central incisor within 0.5 mm gingivally and 1 mm incisally is generally perceived as esthetic as long as horizontal symmetry is maintained (Figure 7). The contour of the gingiva (ie, gingival scallop) to the tip of the papilla should be between 4 mm or 5 mm (Figure 8), and the tips of the papillae should have the same radiating symmetry as the incisal edges and the free gingival margins. In an esthetic smile, the volume of the gingiva from the apical aspect of

the free gingival margin to the tip of the papilla is about 40% to 50% of the length of the maxillary anterior tooth and fully fills the gingival embrasure (Figure 8).²²

In situations where this condition does not exist, periodontal and orthodontic procedures are the treatments of choice to create the correct gingival architecture. Orthodontics not only positions the teeth but also can reposition gingiva and bone. Gingival color should appear pink and healthy or consistent with the healthy color of individual race variations.

DENTAL ANALYSIS: INTRATOOTH AND INTERTOOTH RELATIONSHIPS

Intratooth Relationships

The average length for maxillary central incisors has been measured at between 10 mm to 11 mm.^{11,12,23} In a recent study by Magne,²⁴ the average maxillary length of a unworn maxillary central to the cemento-enamel junction was slightly over 11 mm. Patients who seek esthetics as a primary reason for treatment want to have a full smile with “above average” looking teeth. From measuring esthetic outcomes on hundreds of personal patients and hundreds of resident patients in the UCLA CED, the authors have determined the esthetic zone for the central incisor to be between 10.5 mm and 12 mm. A good length to start the design is 11 mm, as it can be modified based on the many other treatment planning parameters. The width-to-length esthetic relationship has been discussed in the literature to be between 70% to 80%.^{11,22} In measuring smiles in the UCLA CED, the optimal width-to-length ratio for the maxillary central zone was found to be a width of between 75% to 85% of the length. Smiles with these values were most often deemed “esthetic to highly esthetic.” The most esthetically pleasing ratio was 80%. (Figure 9). It is extremely important to note that the esthetic perception of width-to-length ratios is significantly affected by the outline form and the reflective surface of the tooth. The lateral incisors are between 1 mm to a maximum of 2.5 mm shorter than the central. For a more petite smile, more toward the 2 mm to 2.5 mm length is recommended. The canine is slightly shorter than the central between 0.5 to 1 mm.

Intertooth Relationships

When a person smiles and the teeth are displayed, there is an intertooth relationship that needs to be maintained for the composition to be considered esthetic. The maxillary central incisors should be relatively but not perfectly symmetrical. They should dominate but not overwhelm the smile.^{11,21} This is obviously very subjective, but research has shown that in smiles determined to be esthetic, there was a clear dominance of the maxillary central incisor. Many authors recommend using the golden proportion to define the optical width of the maxillary teeth as they go posteriorly.^{21,25,26} One study has demonstrated that the actual measurements of most people’s anterior teeth do not in fact follow the golden proportion.²⁷ It has not been determined that if a person’s optical tooth display followed the golden proportion that this be considered more esthetic than other arrangements. In the authors’ experience, the relationship of the maxillary lateral to central incisor comes very close to the golden proportion in an esthetic smile, and can be used as a guide in shaping teeth. A good guide is to make the optical width of the lateral incisor about 65% of the central incisor (or a little less than two thirds). The authors have found that the canine does not follow the golden proportion optically and is generally about 75% to 80% or about three fourths to four fifths of the optical width of the lateral incisor in smiles that were considered highly esthetic, with an esthetically acceptable zone from 70% to 85% (Figure 9). Figure 10 through Figure 12 shows preoperative or preparatory cases and then postoperative examples with esthetic parameters within the zones discussed.

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