

MAXIMIZING ANTERIOR ESTHETICS: AN INTERDISCIPLINARY APPROACH

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As the new millennium gradually unfolds, the impact on dentistry will be substantial. In the past, the paradigm that controlled dental education and clinical dentistry was devoted to repairing the aftermath of the two major dental diseases (dental caries and periodontitis). However, in most regions of the United States, dental caries in younger individuals has decreased substantially for the past 25 years, due to fluoridation and the use of occlusal sealants. Furthermore, the number of patients with periodontitis also has decreased gradually over the past 10 to 15 years, and today, periodontists are “growing” bone in periodontal patients, rather than removing it.

As the beneficiaries of good dental health in the past become consumers of dental care now and in the future, their personal goals and desires regarding dental care are changing from the gradual repair of old failing restorations to the *proactive* alteration of their anterior dental esthetics. Esthetic dentistry has become a growing portion of most dental practices. Bleaching, anterior single-tooth implants, veneers, all-porcelain crowns, ridge augmentation, and esthetic gingival surgery have become routine today in dentistry. And the future only looks brighter.

But where does the orthodontist fit into this futuristic picture? How will the orthodontic team member contribute to the esthetic improvement of the restorative patient? What esthetic problems should be corrected, and which would go unnoticed by most laypersons? This chapter will call upon recent research to illustrate the orthodontist’s responsibility and role in maximizing dental esthetics for the restorative patient. The information will be divided into four parts based upon the esthetic perspective that is being evaluated: midline, mediolateral incisal angulation, incisal plane, and gingiva-to-lip relationship.

MIDLINE AND MEDIOLATERAL INCISAL INCLINATION

How much could a dental midline deviate before it would be noticed or detected by a layperson or dentist? Is there any difference between

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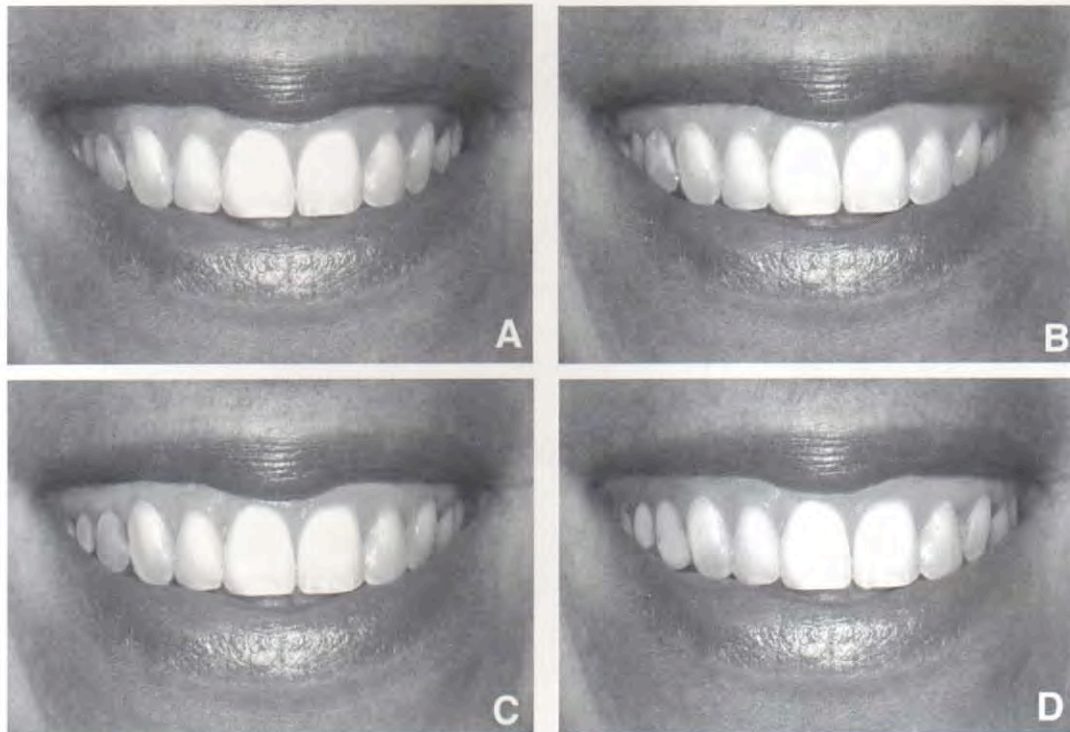


Figure 1. Dental midline alterations. The midline position was adjusted in 1-mm increments. A. 1 mm. B. 2 mm. C. 3 mm. D. 4 mm. The line angle forming the contact between the maxillary central incisors was maintained perpendicular to the incisal plane and parallel to the vertical axis of the photograph.

the two perceptions? In an investigation addressing these questions, Kokich and co-workers (1999) gathered a sample of esthetically-acceptable smiling photographs of young female patients who recently had completed orthodontic therapy. The slides were scanned into a computer, and the smiles were altered digitally to simulate discrepancies in each of the aforementioned categories (midline, mediolateral incisal inclination, incisal plane, and gingiva-to-lip relationship). The alterations or “morphs” were made without altering any other aspect of the photographs.

Four alterations were made for each category. The alterations were made in one-millimeter increments. So, for example, the midline was moved to one side in one-millimeter increments and an image produced at each increment, to a maximum of four millimeters from the center of the upper lip (Fig. 1). The same type of alteration was performed for mediolateral inclination, incisal plane, and gingiva-to-lip relationship. These “morphs” then were organized into a survey that

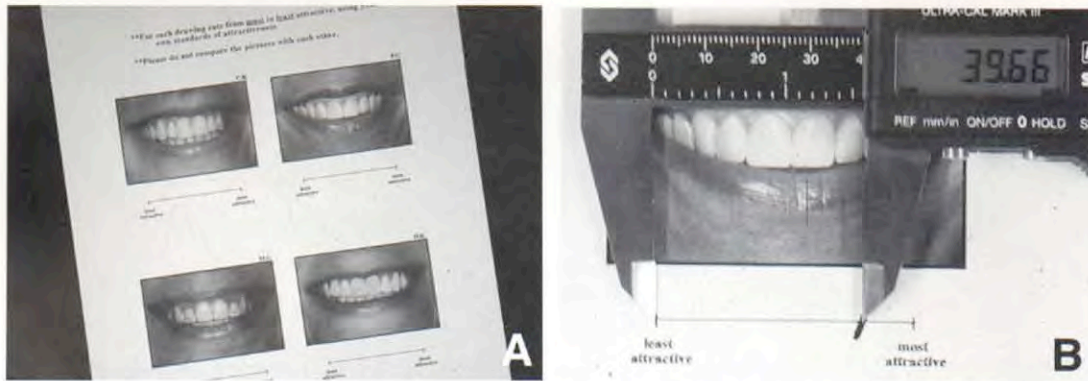


Figure 2. The esthetic survey. *A*. The alterations of each of the four esthetic criteria were arranged randomly in the survey. The resulting images were judged by general dentists, orthodontists, and laypersons. *B*. These individuals were asked to rate their esthetic interpretation from least to most esthetic on a visual analog scale.

was distributed to a panel of orthodontists, general dentists, and laypersons. The photographs in the survey were arranged randomly (Fig. 2*A*), and the panelists were asked to rate the esthetics of the smile from least to most attractive on a 100-millimeter visual analog scale.

The ratings then were compiled (Fig. 2*B*) to determine the “threshold of noticeability.” In other words, at what level of deviation did each group of panelists strongly notice the esthetic problem? For midline deviation (Fig. 1), the laypersons and general dentists did not notice the deviation even at four millimeters (Fig. 1*D*) from the center of the upper lip, whereas the threshold for the orthodontists was four millimeters. So, the orthodontists did not notice the midline deviation at three millimeters (Fig. 1*C*), but did regard it as unesthetic at four millimeters. Now this probably seems absurd to most individuals. How could a midline deviate as much as three millimeters and not be noticed even by orthodontists?

This finding is not that surprising when you view the smiles of four internationally-known celebrities whose photographs were taken from popular magazines or billboard advertisements (Fig. 3). Most of you reading this chapter have seen these individuals’ photographs before. But did you know that their midlines were off by three to four millimeters? Probably not. Why is the midline deviation overlooked in these well-known celebrities? If you look carefully at the photographs, you will notice that even though the midline deviates, the line that forms the contact between the two central incisors is perpendicular to the

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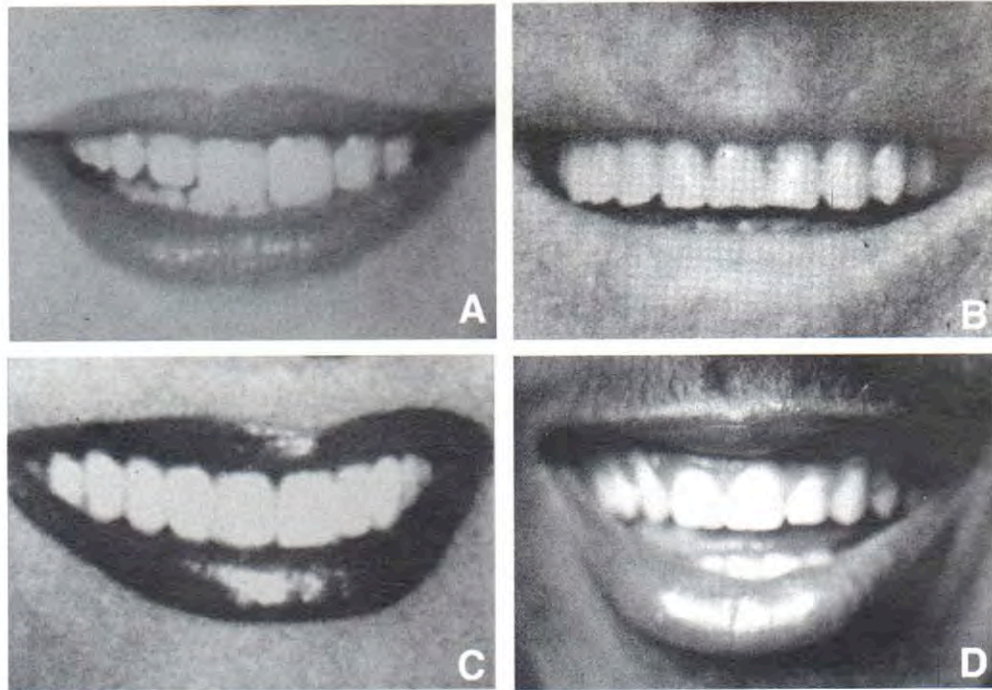


Figure 3. Celebrity midline deviations. Photographs showing the midline positions of four well-known celebrities were taken from popular magazines and billboard advertisements. In each situation, the maxillary dental midline deviates from the facial midline by 3–4 mm.

incisal plane and parallel to the long axis of the individual's face. If this relationship exists, then the midline deviation is camouflaged (Kokich, 1993c).

One implication of this hypothesis is that if the line angle between the contacts were oriented obliquely relative to the patient's face, it could be more noticeable. This hypothesis was tested by having panelists judge deviations in the *mediolateral inclination* of incisors (Fig. 4). How far could the maxillary incisal inclination be deviated before laypersons, general dentists, or orthodontists would rate the deviation as unesthetic? Kokich and associates (1999) altered the control smile photographs by changing the mediolateral incisal inclination in one-millimeter increments, up to four millimeters. They found that the threshold for mediolateral inclination was much lower than for midline inclination. General dentists, orthodontists, and laypersons noticed the problem at two millimeters (Fig. 4). This is not surprising. Figure 5 shows a smiling photograph of a well-known celebrity. Is the dental midline coincident with the facial midline? Some would quickly label the problem as a dental midline deviation. However, the dental midline

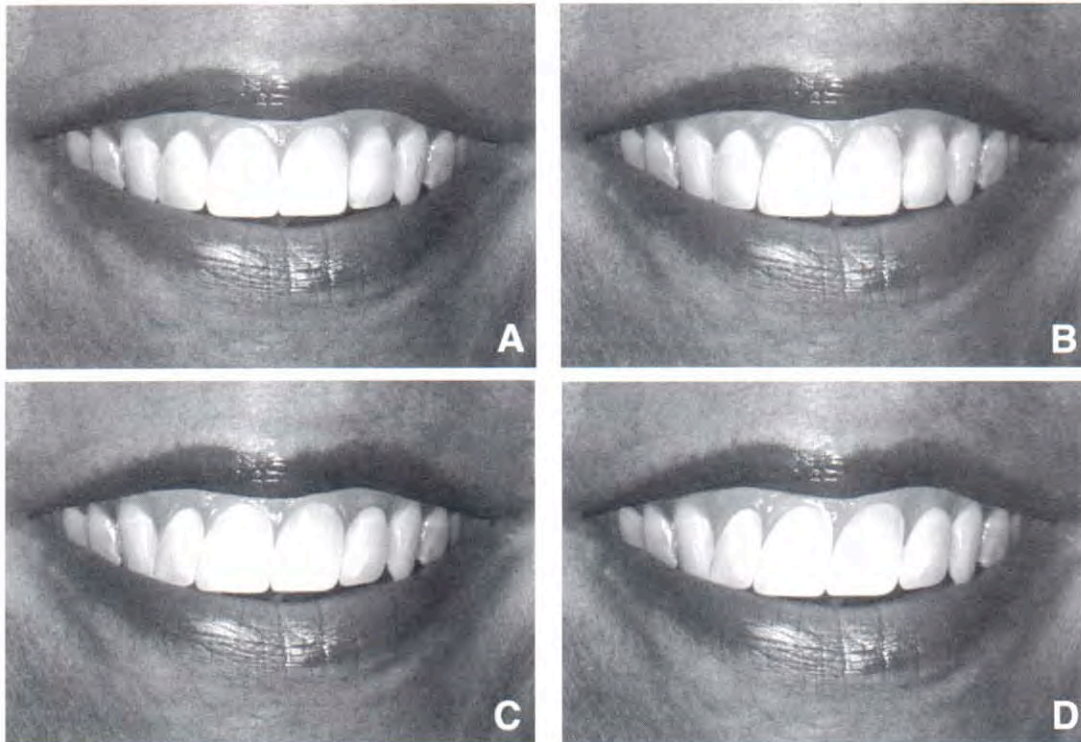


Figure 4. Mediolateral alterations. The mediolateral inclination of the maxillary incisors was adjusted in 1-mm increments. *A.* 1 mm. *B.* 2 mm. *C.* 3 mm. *D.* 4 mm.

does not deviate substantially. The problem is the inclination of the central incisors.

When the contact line between the central incisors deviates more than one or two millimeters, the problem will be noticed easily and often misinterpreted as a midline deviation. For example, the smiling photograph of the female orthodontic patient in Figure 6 suggests that her midline deviates to the left. However, her dental midline is actually coincident with her upper facial midline. How do you evaluate midline deviations? What do you use as a guide for the facial midline? Some clinicians use dental floss and attempt to align the tip of the nose, central incisor interproximal contact, and the center of the chin. However, in many individuals, the tip of the nose is deviated, and the chin also is not a reliable reference. Finally, the central incisor interproximal contact is not the center of the upper teeth.

The best reference for the facial midline in most individuals is the center of the upper lip, which often is called the “tip of cupid’s bow” (Kokich, 1993c). The best reference for the dental midline or the center of the maxillary central incisors is the papilla between these two teeth

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Figure 5. Mediolateral inclination discrepancy. This well-known celebrity has a significant discrepancy in the mediolateral angulation of the maxillary incisors. According to recent research, this esthetic dilemma would be recognized easily by laypersons.

(Kokich, 1993c). If the papilla coincides with the “tip of cupid’s bow,” and the contact deviates, then the problem is not the midline, but the mediolateral incisal inclination. Accurate assessment of the problem is vitally important to the orthodontist, because often the incisal edges and the interproximal contact will not be congruent with one another.

In these situations, the orthodontist must use the angulation of the roots and not the orientation of the incisal edges to determine bracket placement. Often the brackets must be placed at a significant angle to the incisal edges to correct the inclination problem. If the teeth have worn unevenly, the incisal edges often require restoration to re-establish the correct width-to-length relationship of the crowns of the anterior teeth.

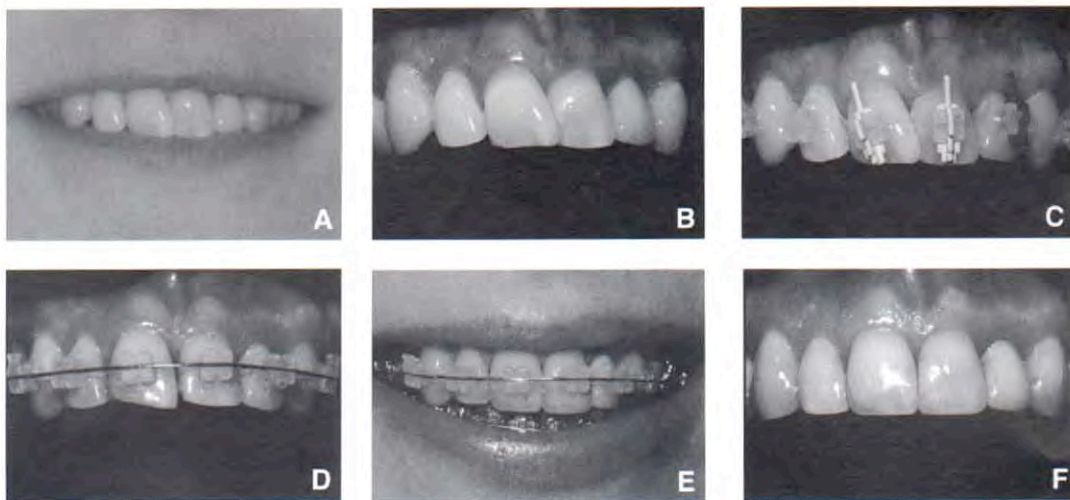


Figure 6. Mediolateral inclination. *A,B*. This patient’s maxillary central incisors are angulated to the left. *C,D*. To treat this situation properly, the orthodontist must place the brackets at an angle, and align the roots, not the incisal edges of the teeth. *E,F*. The restorative dentist may restore the uneven incisal edges during the finishing stage of orthodontic treatment.

How should the findings of this study affect the orthodontist's decision making when one of the objectives is to correct a midline discrepancy (Kokich, 1993c; Kokich and Spear, 1997)? First, if a "true" midline discrepancy affects the posterior occlusion, and correction of the midline discrepancy is necessary to correct the occlusion, then it may be a reasonable objective to correct the deviated midline. If, however, the only reason to correct a midline deviation is for esthetics, current research does not support this approach. The research shows that a midline could deviate by as much as three millimeters, and if the contact between the central incisors is parallel with the long axis of the face and perpendicular to the incisal plane, even dentists would not notice the problem. If, however, the inclination of the teeth deviates by as little as one or two millimeters, then this discrepancy should be treated by uprighting the roots of the central incisors, which will align the contact with the long axis of the face and eliminate the discrepancy.

INCISAL PLANE

Most dentists make their esthetic evaluation of a patient by viewing the individual from the front with the patient standing or sitting upright. From this perspective, one of the important assessments for the restorative dentist is the relationship of the incisal plane to the face. Typically, dentists are taught to use the interpupillary line as a reference for the incisal plane (Lombardi, 1973; Rufenacht, 1990). Although the interpupillary line is not a perfect reference plane, most individuals posture their head so that the interpupillary line is coincident with the horizon or floor. Therefore, if the incisal plane is parallel with the interpupillary line, it also will be parallel with the horizon when the patient smiles. This relationship exists for the majority of individuals.

But some dental patients have incisal planes that deviate from the interpupillary line. Should all incisal plane asymmetries be corrected? If an incisal plane is angled by one or two millimeters, would laypersons notice the discrepancy? Kokich and co-workers (1999) "morphed" the incisal plane of a patient with an ideal smile, by altering the inclination in one-millimeter increments up to four millimeters (Fig. 7). When the panelists evaluated the survey containing these alterations, the threshold for orthodontists and general dentists was one millimeter (Fig. 7B). They were very critical of any alteration in the incisal plane. Laypersons were far less critical of this esthetic

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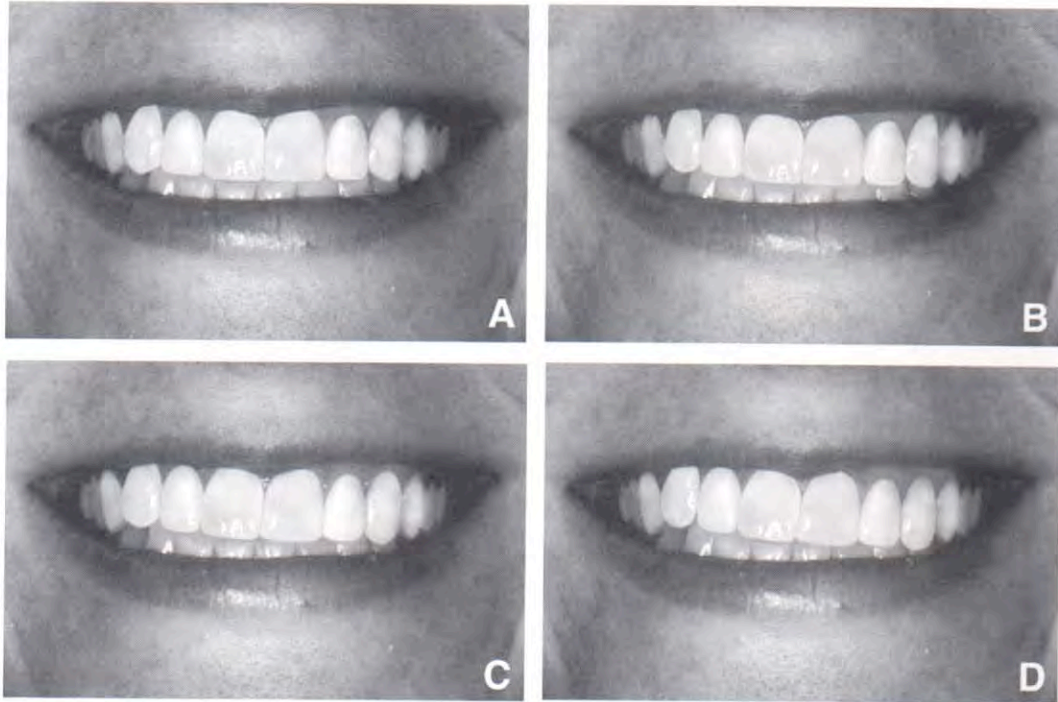


Figure 7. Incisal plane alteration. The incisal plane angulation was adjusted in 1-mm increments. A. 1 mm. B. 2 mm. C. 3 mm. D. 4 mm.

parameter; they rated a one- or two-millimeter deviation in the incisal plane as not unesthetic, but judged that deviations of three millimeters and greater *were* unesthetic. This relationship is a very sensitive barometer of anterior dental esthetics for dentists, and less sensitive for laypersons.

The research has shown that if an incisal plane deviates by as much as three millimeters, it definitely would be noticed by laypersons, as well as dentists and orthodontists. How should an incisal plane asymmetry be corrected? There are three possible treatment alternatives: maxillofacial surgery, orthodontics, and restorative dentistry. An oral surgeon can reorient an asymmetric incisal plane by performing maxillofacial surgery. An orthodontist can reorient an incisal plane by intruding or extruding the maxillary incisors. Finally, a restorative dentist could restore and/or equilibrate the incisal edges to correct an incisal plane discrepancy. How does the clinician identify the appropriate solution? The key is the diagnosis (Kokich, 1993*b*).

The first step is to evaluate the relationship of the incisal plane to the interpupillary line to determine if there truly is a problem. The patient in Figure 8 was concerned about her “crooked smile”; her incisal

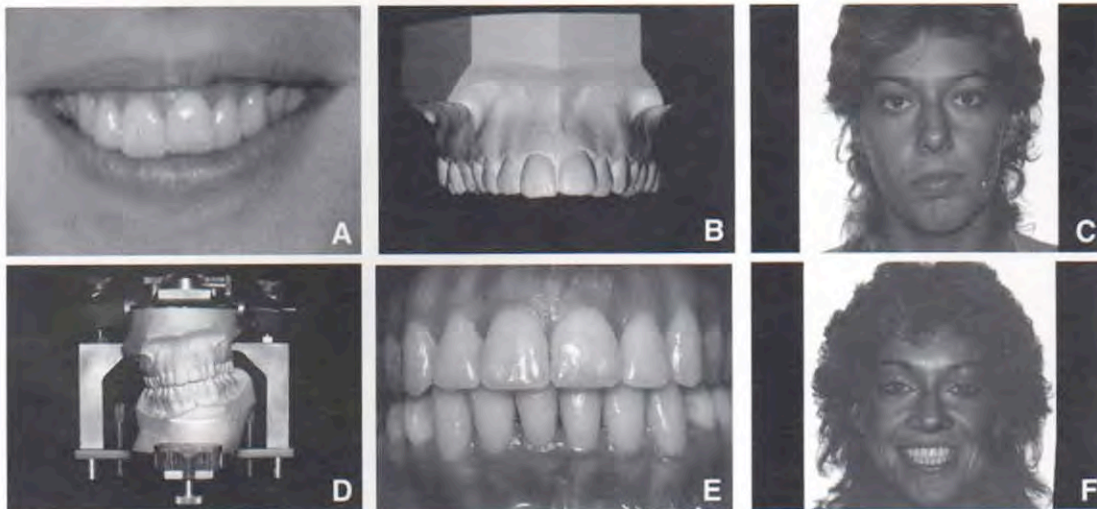


Figure 8. Incisal plane discrepancy. *A*. This patient's incisal plane deviated significantly from her interpupillary line. *B*. The incisal and occlusal planes were coincident. *C, D*. Thus, the etiology of the problem was asymmetric mandibular growth. *E, F*. Orthognathic surgery was performed to correct the condition.

plane was canted. If the discrepancy were only one millimeter, research shows that most laypersons would not notice the problem. However, her discrepancy deviates by three millimeters. All panelists would regard this as unesthetic. The clinician then must evaluate the relationship between the incisal plane and the posterior occlusal plane (Fig. 8*B*). In this patient, the two planes are coincident. If both incisal and occlusal planes deviate from the interpupillary line, the problem is due to unilateral asymmetric growth of the ramus of the mandible.

Greater growth of one ramus permits greater eruption of the posterior and anterior teeth on that side relative to the contralateral side. This produces a cant to the anterior and posterior occlusal planes (Fig. 8*D*). The only method for correcting this problem is maxillofacial surgery to reposition the maxilla and mandible and re-orient the incisal and posterior occlusal planes with the interpupillary line (Fig. 8*C, F*). Of course, adjunctive orthodontics would be necessary to establish proper interdigitation of the teeth (Fig. 8*E*), but tooth movement does not correct the incisal plane when the problem is due to asymmetric growth.

Although dentists encounter patients with asymmetric growth, a more common type of incisal asymmetry (Kokich, 1993*b*) is seen in the patient in Figure 9. Her incisal plane deviates from the

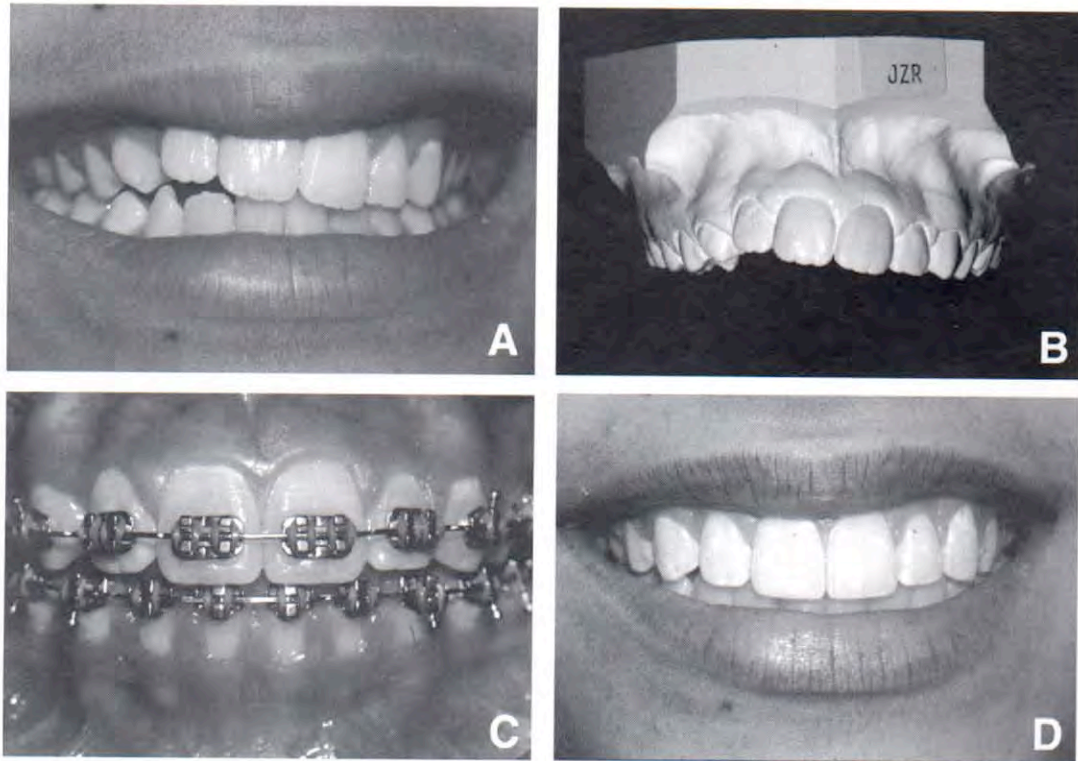


Figure 9. Incisal plane discrepancy. *A.* This patient's incisal plane significantly deviated from the interpupillary line (not shown). *B.* The incisal plane deviated from the posterior occlusal plane, but the posterior occlusal plane was coincident with the interpupillary line, and was therefore *not* caused by asymmetric mandibular growth. *C,D.* The solution was orthodontic extrusion of the partially erupted teeth, and termination of a finger habit.

interpupillary line by more than three millimeters and would be considered unesthetic. However, because her incisal plane also deviates from the posterior occlusal plane, the clinician must assess the relationship between the posterior occlusal plane and the interpupillary line. In this patient, the posterior occlusal plane is coincident with the eyes. Therefore, the problem is not due to asymmetric mandibular growth. No uneven posterior eruption has occurred. The clinician's final assessment should be a comparison of the crown lengths of the incisors to determine if the teeth have worn or abraded unevenly to produce the canted incisal plane. However, this patient does not have worn incisal edges. The etiology of the problem most likely is a finger habit. The solution is to eliminate the habit, erupt the anterior teeth, and level the incisal plane so that it matches the posterior occlusal plane.

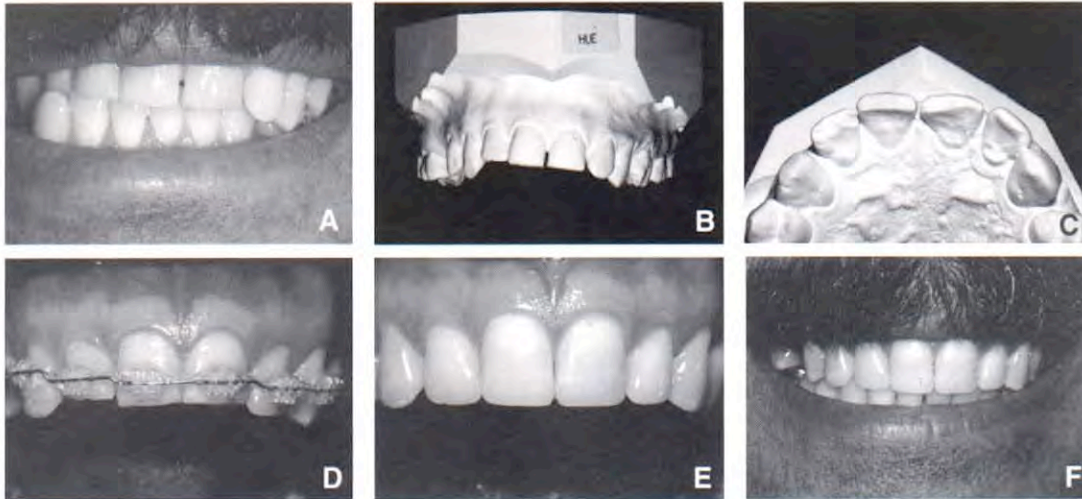


Figure 10. Incisal plane discrepancy. *A.* This patient's incisal plane deviated from the interpupillary line. *B.* The incisal plane deviated from the posterior occlusal plane, but the posterior occlusal plane was coincident with the interpupillary line. *C-F.* Because the maxillary incisal edges were abraded, the orthodontics involved leveling of the gingival margins and restoration of the incisal edges to correct the discrepancy.

Restorative dentists also will encounter incisal plane asymmetries in patients that require restorative dentistry (Kokich, 1993*b*). The patient in Figure 10 has a significant incisal plane discrepancy that is greater than three millimeters. His incisal plane deviates from the posterior occlusal plane, but the posterior occlusal plane is coincident with the interpupillary line, so the cause of the discrepancy is not asymmetric mandibular growth. The solution to the problem certainly will require restoration of the incisors, as they have been abraded significantly. However, the orthodontist must first position the gingival margins of these teeth in their proper vertical relationship. The level of the central and canine gingival margins should be even, and the lateral incisor gingival margin should be positioned slightly more coronally (Chiche *et al.*, 1994; Kokich, 1990, 1993*a*, 1996, 1997). When the proper gingival margin relationship has been established, the restorative dentist can restore the incisal edges and create the appropriate crown-to-width relationship of the maxillary central incisors.

In these three examples of incisal plane asymmetry, the asymmetries all were three millimeters or greater. All three examples would be regarded as unesthetic by laypersons, and therefore all should be corrected. However, the method of correction to realign the incisal plane was different in each situation. The key was in the diagnosis. All

members of the interdisciplinary team must be able to diagnose these types of problems so the appropriate solution is rendered in each situation.

GINGIVA-TO-LIP RELATIONSHIP

When an individual smiles, the upper lip ideally exposes the entire length of the maxillary central incisors. The resulting lip level theoretically aligns with the gingival margins of the maxillary central incisors. In this situation, little if any gingiva is apparent apical to the gingival margins. However, many patients show two or more millimeters of gingiva when they smile. If the problem is severe, *e.g.*, greater than four millimeters of gingiva show above the gingival margins, the condition commonly is referred to as a “gummy smile.” Some clinicians regard this situation as unesthetic. What did the study show?

Kokich and associates (1999) altered an ideal smile by increasing the distance between the gingival margin of the maxillary central incisors and the upper lip. The alterations were made in two-millimeter increments from zero to six millimeters between the upper lip and gingival margin (Fig. 11). These photographs were incorporated into the questionnaire and shown to general dentists, orthodontists, and laypersons. The results were interesting. The threshold for the orthodontists was two millimeters. In other words, the orthodontists considered a smile that exposed two millimeters of gingiva to be unesthetic. To the orthodontist, the ideal situation occurred when the gingival margin was coincident with the upper lip. General dentists and laypersons disagreed. Their threshold was four millimeters. So, if two millimeters of gingiva exists between the lip and gingival margins and the smile is not considered unesthetic to general dentists and laypersons, should it be corrected?

If a patient has a gummy smile of four millimeters or greater, three options are available (Kokich, 1993*b*; Kokich and Spear, 1997). One option is orthognathic surgery to move the maxilla apically. A second option is periodontal surgery to move the gingival margin apically. A third option is orthodontic intrusion of the maxillary central incisors, which also will move the gingival margin apically and eliminate the gummy smile. But how does the clinician choose among the three options? Once again, the key is in the diagnosis.

The patient in Figure 12 shows five millimeters of gingiva when smiling. Based upon our results described above, this would be

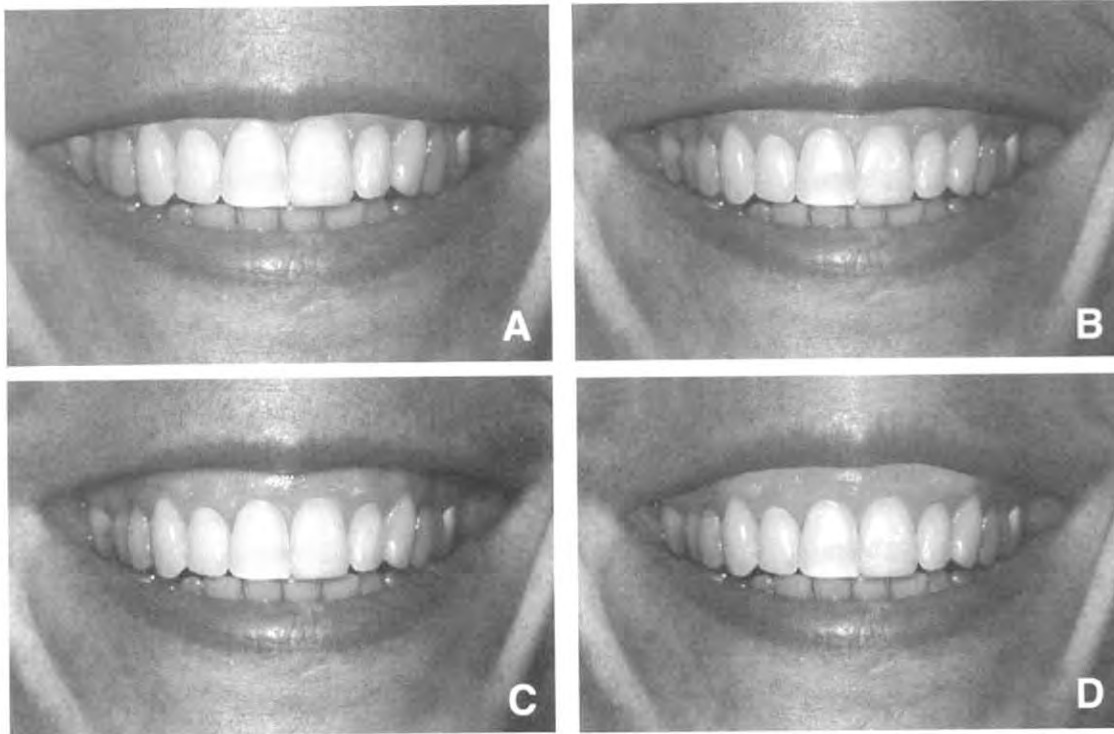


Figure 11. Gingiva-to-lip relationship alterations. The distance between the upper lip and the gingival margins of the maxillary incisors was altered in 2-mm increments to produce a “gummy smile” for the survey. A. 0 mm. B. 2 mm. C. 4 mm. D. 6 mm.

considered unesthetic. How should it be corrected? The first step in the diagnostic process is to determine if the excess gingiva is apparent in the anterior or in both the anterior and posterior portions of the mouth (Kokich, 1993*b*). In this patient, the excess gingiva is apparent anteriorly and posteriorly. This problem often is termed *vertical maxillary excess*. It cannot be corrected with orthodontic intrusion, because the orthodontist cannot intrude all of the maxillary teeth.

Therefore, the solution would be either jaw surgery or periodontal surgery. To choose between these two options, the clinician must evaluate the patient’s crown length. If periodontal surgery is performed, the crown length will increase. Does the patient need longer crown length? The crown length of a central incisor really is a function of the width of the tooth. The width-to-length relationship of any maxillary central incisor should be between 67–80% (Kokich, 1990; Rufenacht, 1990). This patient’s crowns actually are very long relative to their width. So, periodontal surgery is not appropriate. The solution for this patient is maxillary surgery to remove a segment of bone and intrude the

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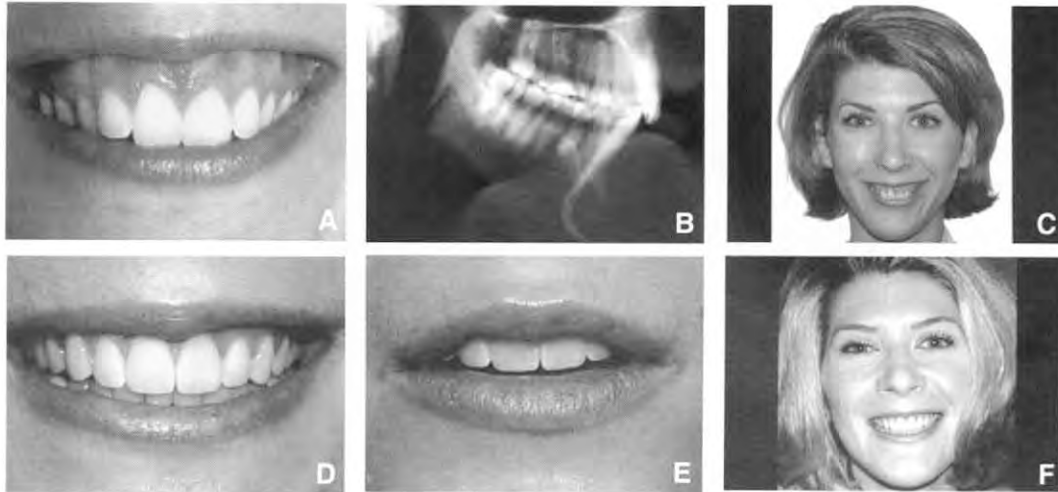


Figure 12. Gummy smile. *A*. This patient showed 5 mm of gingiva between the upper lip and gingival margin of the maxillary incisors, and the excessive gingival display was present in the anterior and posterior. The crowns had the correct width-to-length relationship, indicating maxillofacial surgery as the appropriate treatment. *B–D*. The resting lip length was 8 mm before surgery, allowing intrusion of the maxilla by 5 mm to eliminate the gummy smile. *E, F*. Three millimeters of incisal edge show at rest following surgery.

maxilla. But is this patient a surgical candidate? That can only be determined by evaluating the patient's resting lip length.

For a young female, about three millimeters of the incisal edge should be apparent when the upper lip is at rest. The distance between the upper lip and incisal edge with the lip at rest in this patient is eight millimeters (Fig. 12). Therefore, a five-millimeter segment of bone could be removed from the maxilla, and the maxilla could be intruded surgically. This procedure would result in three millimeters of the maxillary central incisors showing at rest after surgery, and the lip would rise just to the level of the gingival margin when the patient smiles. However, if this patient's resting lip length were three millimeters prior to surgery, and the maxilla were impacted five millimeters, the patient would not show any of her maxillary incisors at rest. This would be extremely unesthetic. Patients who show excessive gingiva when they smile, and have normal crown length and resting lip length usually have what is called a *hypermobile* lip. This problem is almost impossible to ameliorate predictably.

A second example of a gummy smile is illustrated in Figure 13, and is seen frequently by orthodontists during treatment of adolescent

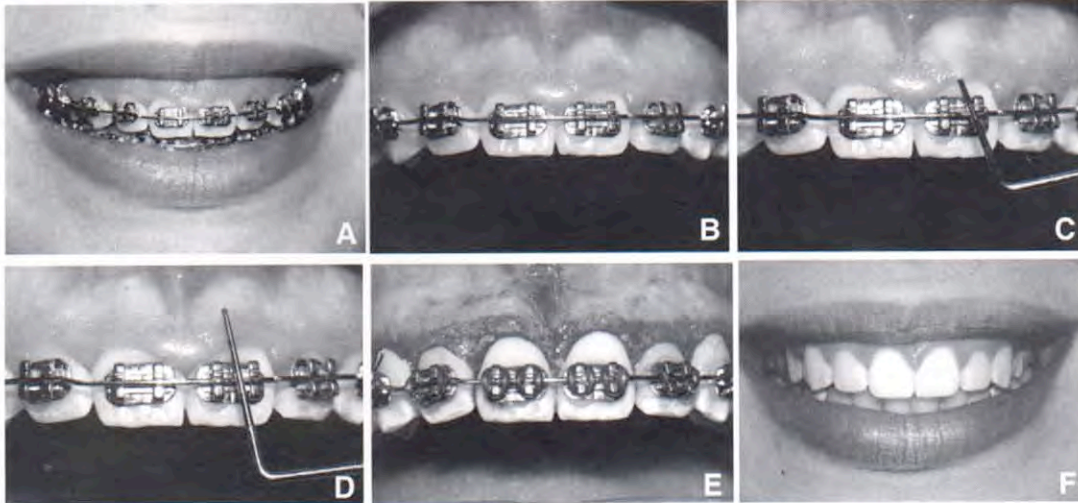


Figure 13. Gummy smile. *A.* This patient showed 4 mm of gingiva when she smiled, and the problem was seen in the anterior and posterior. *B.* The width-to-length relationship of the maxillary central incisors was disproportionate, in this case, too short. *C,D.* Periodontal probing revealed a 4 mm sulcular depth. *E,F.* Thus, excisional gingival surgery was the treatment of choice to eliminate the gummy smile.

patients. The patient shows four millimeters of gingiva when she smiles. This would be classified as unesthetic, according to the study. How should it be corrected? This patient also shows the gingiva in the anterior and posterior. Therefore, the problem cannot be corrected with orthodontic intrusion. Jaw surgery or periodontal surgery thus are the only options to correct the gummy smile. The next step, assessment of the crown length of the central incisors, showed a width-to-length ratio of almost 1:1; they are too short. The next step is to evaluate the gingival sulcular depth. This patient has a sulcular depth of four millimeters. It should be one millimeter.

This patient has a common problem that orthodontists see almost daily—*delayed passive eruption*. In this situation, the bone has migrated apically, but the gingiva still covers the coronal portion of the clinical crown of the maxillary central incisors. If the gingiva is thick, as in this patient, it likely will not migrate spontaneously. Therefore, excisional gingival surgery is the appropriate method to correct the gummy smile in this instance (Kokich, 1993*b*). After surgery, the width-to-length relationship of the central incisor crowns is within the ideal range, and the patient shows only one millimeter of gingiva when she smiles.

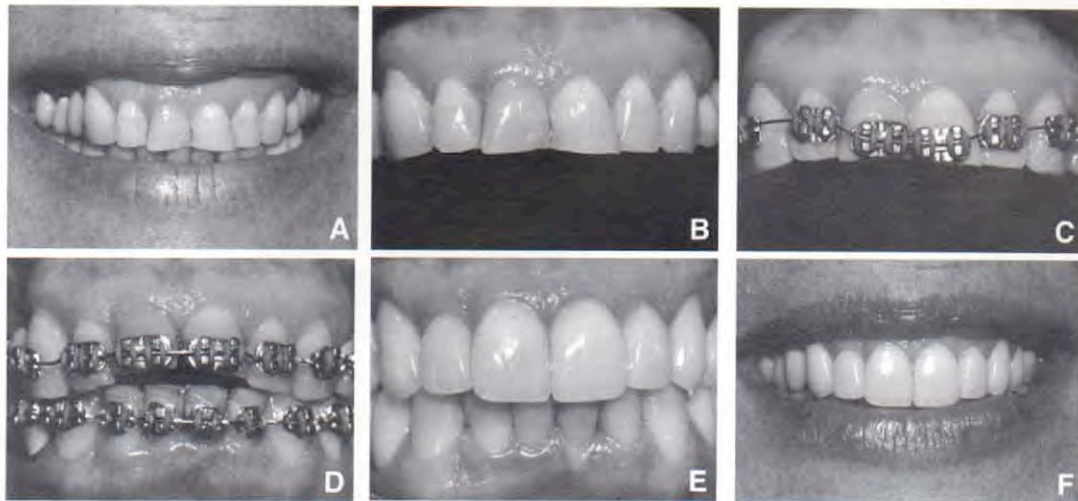


Figure 14. Gummy smile. *A*. This patient showed 4 mm of gingiva, but the problem was apparent only in the anterior. *B*. The crowns were short, but the sulcular depths were only 1 mm. The incisal edges had abraded and the teeth had overerupted. *C–F*. The correction of the gummy smile involved orthodontic intrusion of the incisors, and restoration of the incisal edges.

The final patient illustrates the third method for correcting a gummy smile. This patient shows four millimeters of gingiva when she smiles, and she dislikes the esthetic appearance of her teeth (Fig. 14). This patient differs from the previous two examples in that she only shows the excess gingiva anteriorly and *not* in the posterior (Kokich, 1993*b*; Kokich and Spear, 1997). Therefore, jaw surgery is not indicated. Second, her crown width-to-length proportion is almost 1:1. Her teeth definitely need to be longer. The sulcular depths are all normal at one millimeter. The incisal edge is positioned ideally at the level of the posterior occlusal plane. The only two options for correcting the gummy smile are: (1) periodontal surgery to apically position the gingival margin and expose the roots of the teeth, or (2) orthodontic intrusion to move the central incisors apically, and restorative dentistry to re-establish the correct width-to-length relationship of the maxillary central incisors.

The final decision is based upon an evaluation of the crown-to-root ratio of the maxillary central incisors. If periodontal surgery were performed, this ratio would worsen. This patient already has short roots, and periodontal crown lengthening would make the situation worse. Therefore, the best solution is orthodontic intrusion and restoration (Kokich, 1993*b*; Kokich and Spear, 1997). It is important that the orthodontist be aware of the plan at the outset. The brackets must be

placed near the incisal edges of the central incisors, so that they will intrude relative to the adjacent teeth. As the teeth intrude, the gingival margins migrate apically. Eventually, the incisal edges can be restored temporarily with a plastic restoration and more permanently later with a porcelain crown or veneer. Even though the patient showed four millimeters of gingiva on smiling, orthodontic intrusion was capable of moving the gingival margin apically so the patient only showed about a millimeter of gingiva at the end of treatment.

The three cases presented in this section illustrate that gummy smile has multiple solutions. The key for the interdisciplinary team is to properly diagnose the source of the problem and then determine the appropriate sequence of treatment for each patient.

CONCLUSIONS

This chapter has attempted to accomplish two objectives. The first objective was to demonstrate that we should recommend esthetic correction of tooth malposition only if it is truly unesthetic to the layperson. Much of what dentists believe about esthetic relationships simply is theory. The study that was referenced repeatedly in this chapter actually gives the clinician some scientifically generated guidelines to assess the severity of certain esthetic relationships.

The second objective of the chapter was to give the interdisciplinary team some guidelines to follow when determining the most appropriate solution for a particular unesthetic situation. The criteria given in this paper may seem simplistic to some clinicians, but they are easily understood by *all* members of the interdisciplinary team. This common diagnostic approach ensures that no matter who on the team is evaluating the patient, the appropriate solution will be consistently selected. This is the interdisciplinary approach to esthetic dentistry.

REFERENCES

- Chiche G, Kokich V, Caudill R. Diagnosis and treatment planning of esthetic problems. In: Chiche G, Pinault A, eds. *Esthetics of anterior fixed prosthodontics*. Chicago: Quintessence, pp. 33–52, 1994.
- Kokich VG. Enhancing restorative, esthetic and periodontal results with orthodontic therapy. In: Schluger S, Yuodelis R, Page R, Johnson R, eds. *Periodontal therapy*. Philadelphia: Lea and Febiger, pp. 433–460, 1990.
- Kokich V. Anterior dental esthetics: an orthodontic perspective. I. Crown length. *J Esthet Dent* 1993a;5:19–23.

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- Kokich V. Anterior dental esthetics: an orthodontic perspective. II. Vertical relationships. *J Esthet Dent* 1993b;5:174–178.
- Kokich V. Anterior dental esthetics: an orthodontic perspective. III. Mediolateral relationships. *J Esthet Dent* 1993c;5:200–207.
- Kokich VG, Spear F. Guidelines for treating the orthodontic-restorative patient. *Semin Orthod* 1997;3:3–20.
- Kokich VG. Esthetics and vertical tooth position: the orthodontic possibilities. *Compendium Cont Ed Dent* 1997;18:1225–31.
- Kokich VG. Esthetics: the orthodontic-periodontic restorative connection. *Semin Orthod* 1996;2:21–30.
- Kokich VO, Kiyak A, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. *J Esthet Dent* 1999;11:311–324.
- Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. *J Prosthet Dent* 1973;9:358.
- Rufenacht C. *Fundamentals of esthetics*. Chicago: Quintessence, 1990.