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A Multidisciplinary Approach to Esthetic Dentistry

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In the past 25 years, the focus in dentistry has gradually changed. Years ago, dentists were in the repair business. Routine dental treatment involved excavating dental caries and filling of the enamel and dentinal defects with amalgam. In larger holes, more durable restorations may have been necessary, but the focus was the same: repair the effects of dental decay. However, with the advent of fluorides and sealants, in addition to the emergence of a better understanding of bacteria's role in causing both caries and periodontal disease, the needs of the dental patient have gradually changed. Many young adults who are products of the sealant generation have little or no decay and few existing restorations. At the same time, our image of the value of teeth in Western society has also changed. Yes, the public still regards teeth as an important part of chewing, but today the focus of many adults has shifted toward esthetics. How can my teeth be made to look better? Therefore, the formerly independent disciplines of orthodontics, periodontics, restorative dentistry, and maxillofacial surgery must often join together to satisfy the public's desire to look better.

This trend toward a heightened awareness of esthetics has challenged dentistry to look at dental esthetics in a more organized and systematic manner, so that the health of patients and their teeth is still the most important underlying objective. But some existing dentitions simply cannot be restored to a more pleasing appearance without the assistance of several different dental disciplines. Today, every dental practitioner must have a thorough understanding of the roles of these various disciplines in producing an esthetic makeover, with the most conservative and biologically sound interdisciplinary

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treatment plan possible. The authors have worked in such an environment for the past 20 years. As prosthodontist and orthodontist, we have belonged to an interdisciplinary study group consisting of nine dental specialists and one general dentist since 1984 [1]. We have met monthly since that time to (1) educate one another about the advances in each of our respective areas of dentistry and (2) to plan interdisciplinary treatment for some of the most challenging and complex dental situations. One of these interdisciplinary areas is esthetics. This article provides a systematic method of evaluating dentofacial esthetics in a logical, interdisciplinary manner.

Sequencing the planning process

Historically, the treatment planning process in dentistry usually began with an assessment of the biology or biological aspects of a patient's dental problem. This could include the patient's caries susceptibility, periodontal health, endodontic needs, and general oral health. Once the biologic health was reestablished either through caries removal, modification of the bone or gingiva, endodontic therapy, or tooth removal, then the restoration of the resulting defects would be based upon structural considerations. If teeth were to be restored or repositioned, the function of the teeth and condyles would be of paramount importance in dictating occlusal form and occlusal relationships, respectively. Finally, esthetics would be addressed to provide a pleasing appearance of the teeth. However, if the treatment planning sequence proceeds from biology to structure to function and finally to esthetics, the eventual esthetic outcome may be compromised. We proceed in the opposite direction. That is, we start the treatment planning process with esthetics and proceed to function, structure, and finally biology. We do not leave out any of the important parameters; we simply sequence the planning process from a different perspective. We choose this sequence because the decisions made in each category, especially esthetics, directly affect the following categories.

Beginning with esthetics in mind

When beginning with esthetics, we must begin with an appraisal of the position of the maxillary central incisors relative to the upper lip (Fig. 1). This assessment is made with the patient's upper lip at rest. Using a millimeter ruler or a periodontal probe, we determine the position of the incisal edge of the maxillary central incisor relative to the upper lip. The position of the maxillary central incisor can either be acceptable or unacceptable. An acceptable amount of incisal edge display at rest depends on the patient's age. Previous studies have shown that with advancing age, the amount of incisal display decreases proportionally [2,3]. For example, in a 30-year-old, 3 mm of incisal display at rest is appropriate. However, in a 60-year-old, the incisal display could be 1 mm or less. The change in incisal display

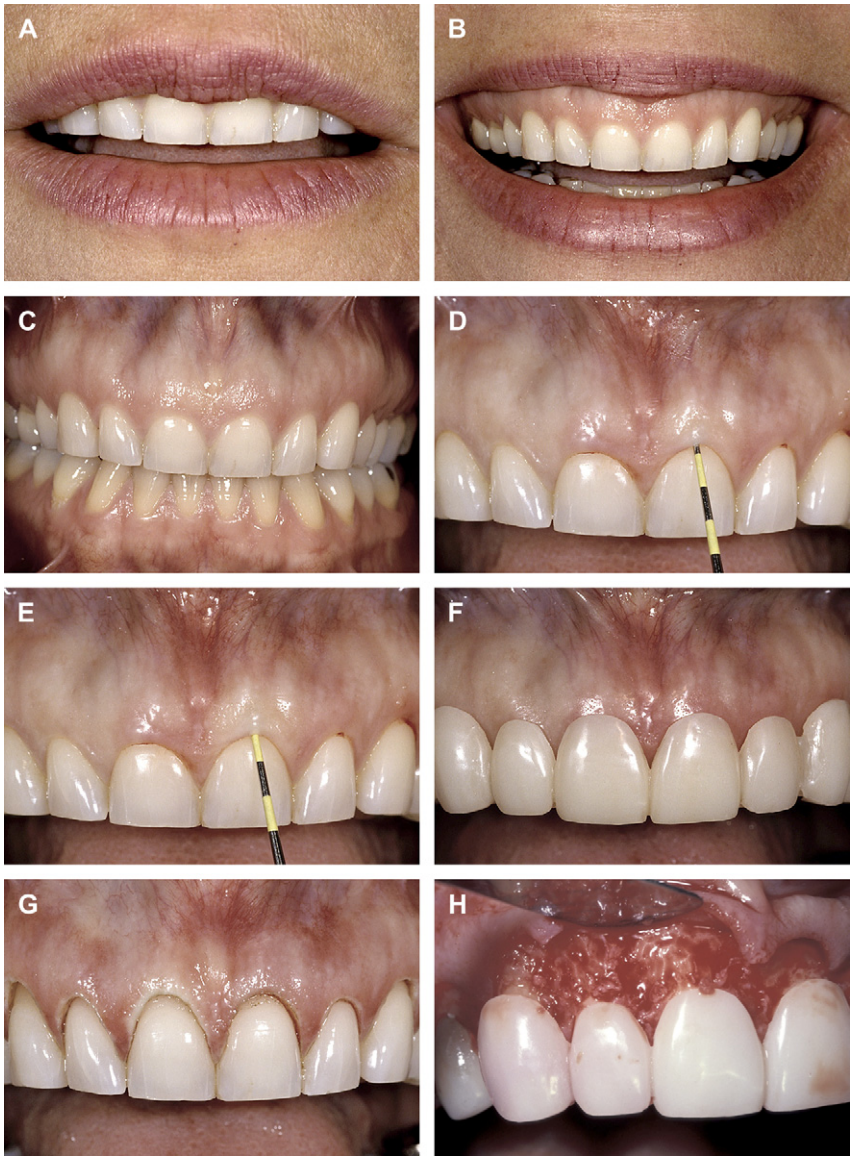

Fig. 1. This 35-year-old adult female showed about 3 mm of her maxillary central incisal edges with her lip at rest (*A*). However, she showed excessive gingiva when she smiled (*B*). Her occlusion was satisfactory, and she did not need orthodontic treatment (*C*). Her maxillary crown length was short, but the sulcus depth was normal (*D*). Sounding of the bone (*E*) showed that she had altered active eruption with the bone levels located at the cementoenamel junctions. A stent representing the desired crown length (*F*) was placed onto the upper teeth, and a gingivectomy was performed at that level (*G*). Then, a flap was elevated (*H*) showing the bone near the cementoenamel junction. The bone level was moved 3 mm above the desired gingival margins (*I*). After 5 years post-treatment (*J*), not only is the tissue healthy, but the ideal amount of gingiva is showing at rest (*K*) and during smiling (*L*).

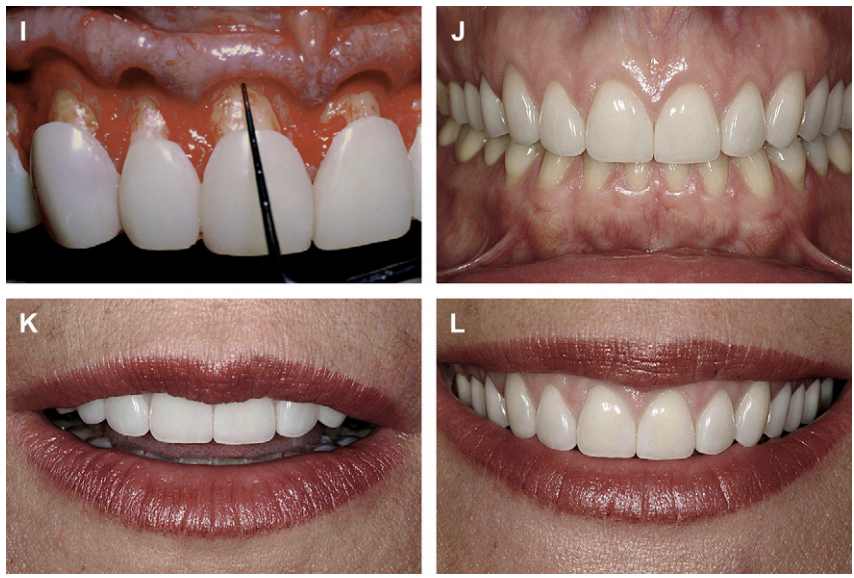

Fig. 1 (*continued*)

with time probably relates to the resiliency and tone of the upper lip, which tends to decrease with advancing age.

If the incisal edge display is inadequate (Fig. 2), then a primary objective of interdisciplinary treatment may be to lengthen the maxillary incisal edges. This objective could be accomplished with restorative dentistry [4], orthodontic extrusion [5], or orthognathic surgery [6–8]. Choosing the correct procedure depends upon the patient's facial proportions, existing crown length, and opposing occlusion. If the incisal edge display is excessive (Fig. 3), then an objective of treatment could be to move the maxillary incisors apically either by equilibration [9], restoration [10], orthodontics [11,12], or orthognathic surgery [13]. The selection among these disciplines again depends on the patient's existing anterior occlusion, the patient's facial proportions, or both.

The second aspect of esthetic tooth positioning to be evaluated is the maxillary dental midline. Recent studies have shown that lay people do not notice midline deviations to the right or left of up to 3 or 4 mm if the long axes of the teeth are parallel with the long axis of the face [14,15]. So, perhaps the most important relationship to evaluate is the medio-lateral inclination of the maxillary central incisors. If the incisors are inclined by 2 mm to the right or left, lay people regard this discrepancy as unesthetic [15,16]. A canted midline can be corrected with orthodontics [17] or restorative dentistry [18]. Usually the choice depends upon whether the maxillary incisors will require restoration.

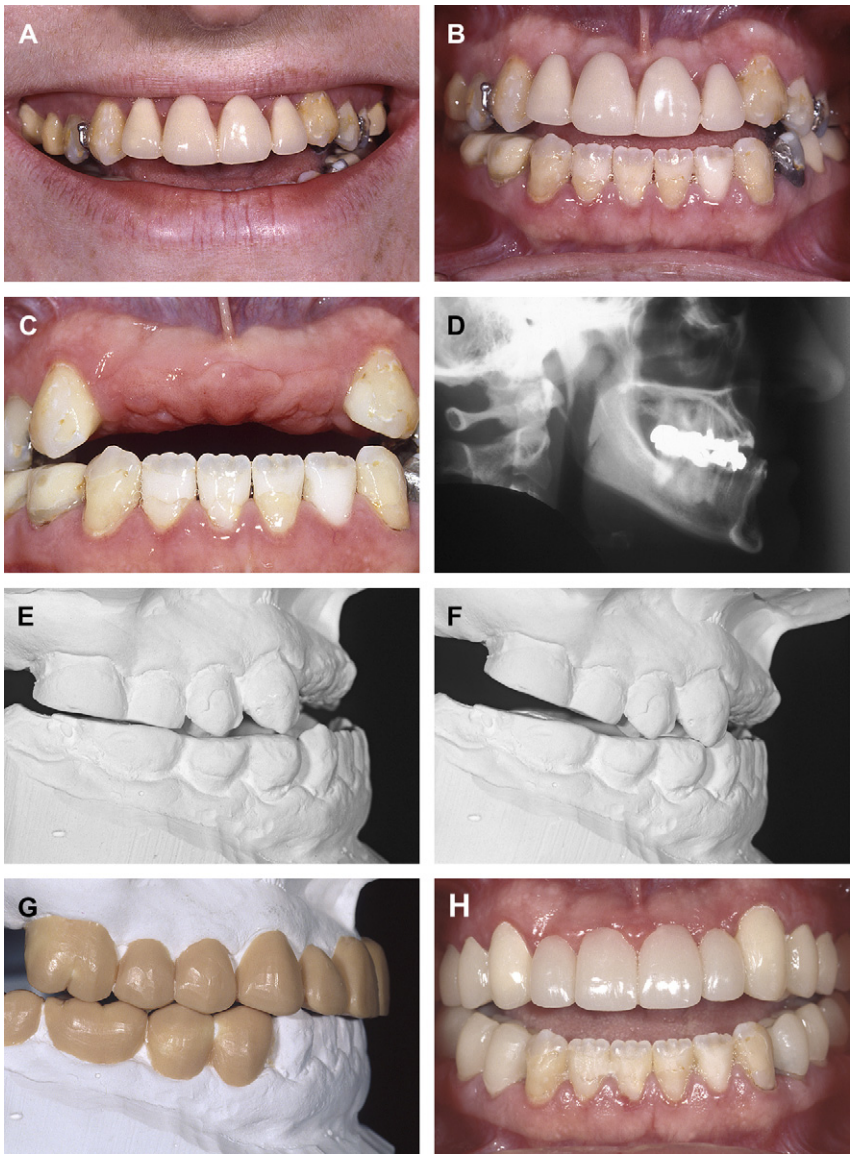

Fig. 2. This adult female lost her maxillary incisors in a childhood accident and was wearing a maxillary removable prosthesis (*A*). When smiling, her maxillary incisors were in the correct relationship relative to the upper lip, but the incisal edges were above the posterior occlusal plane (*B*), giving the patient an anterior openbite. Her past dental care was sporadic with decay and attrition noted in several areas (*C*). She had maxillary retrognathia (*D*). Orthognathic surgery was planned to move the maxillary posterior teeth apically to close the openbite but maintain the level of the maxillary incisal edges (*E* and *F*). A diagnostic wax-up (*G*) was used to fabricate provisional crowns, which were cemented (*H*) the day before jaw surgery. Orthodontic appliances were placed immediately before the surgery to stabilize the jaws after surgery (*I*). Implants were placed in the lateral incisor regions (*J*) and restored with a four-unit implant-supported bridge (*K*), which improved the patient's smile (*L*).

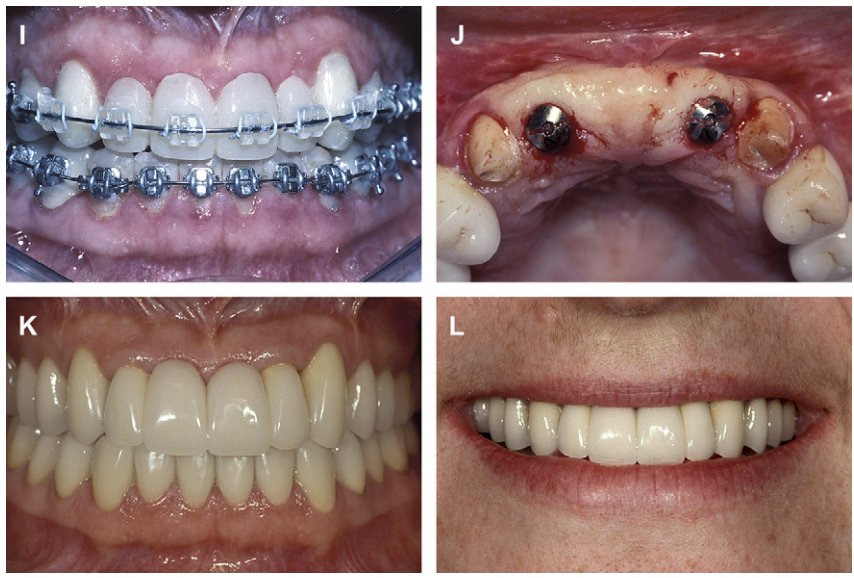

Fig. 2 (*continued*)

Maxillary incisor inclination

Once we have established the correct incisal edge position and midline relationship of the maxillary incisors, the next step is to evaluate the labiolingual inclination of the maxillary anterior teeth. Are they acceptable, proclined, or retroclined? When orthodontists evaluate labiolingual inclination, they rely on cephalometric radiographs to determine tooth inclination [19]. However, general dentists do not use these radiographs. Another method of assessing the inclination of the maxillary anterior teeth is to evaluate the labial surface of the existing maxillary central incisors relative to the patient's maxillary posterior occlusal plane. Generally, the labial surface of the maxillary central incisors should be perpendicular to the occlusal plane. This relationship permits maximum direct light reflection from the labial surface of the maxillary central incisors, which enhances their esthetic appearance [20]. If teeth are retroclined or proclined, correction may require either orthodontics or extensive restorative dentistry and possibly endodontics to establish a more ideal labiolingual inclination [18].

The next step is to evaluate the maxillary posterior occlusal plane relative to the ideal location of the maxillary incisal edge. Either the maxillary incisal edge will be level with the posterior occlusal plane (see Fig. 1; Figs. 4 and 5), coronal to the posterior occlusal plane (see Fig. 3; Fig. 6), or apical to the posterior occlusal plane (see Fig. 2). Correcting the posterior occlusal plane position requires orthognathic surgery [21,22], restorative dentistry [18], or both. The amount of tooth abrasion, the patient's vertical facial

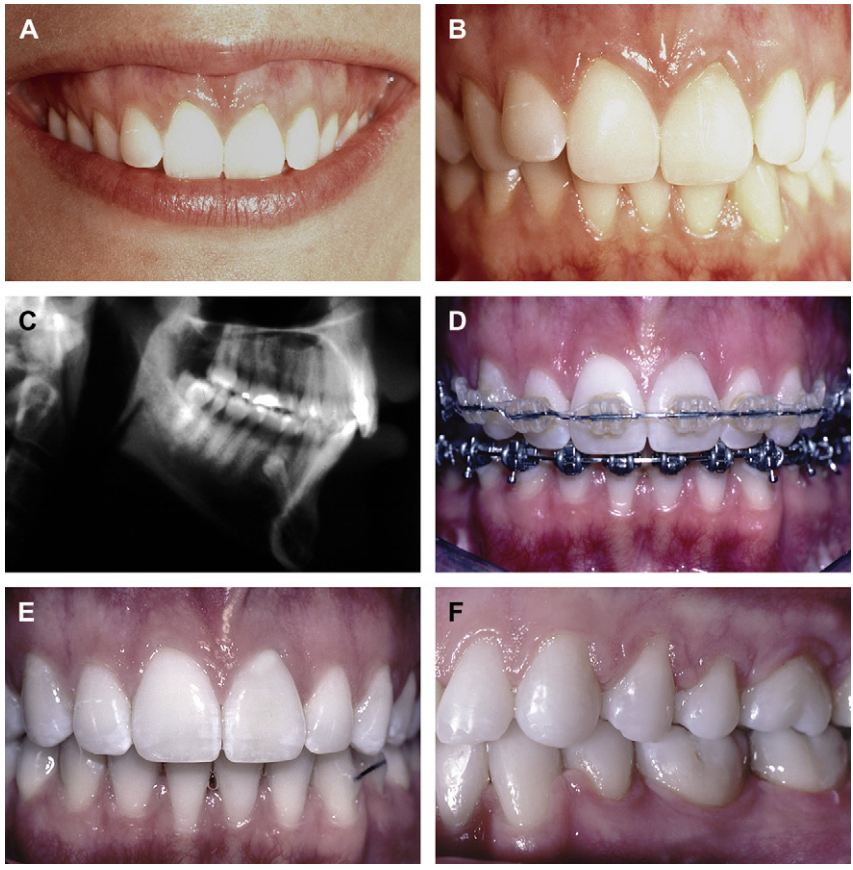

Fig. 3. This 30-year-old female was concerned about her "gummy smile" (*A*). She showed 5 mm of gingiva when she smiled, but the width-to-length relationship of her maxillary central incisors was ideal (*B*). She showed 8 mm of her maxillary incisors at rest (*C*) and, therefore, was diagnosed with maxillary alveolar hyperplasia. Orthodontics was used to coordinate the midlines (*D*), and maxillary impaction surgery was used to shorten her upper facial height and reduce the amount of gingiva. Her final occlusion (*E* and *F*) was improved significantly, and 5 years after orthodontic treatment, her smile still looks excellent (*G*) and her occlusion has been nicely maintained (*H* and *I*).

proportions, and the position of the alveolar bone help determine the correct solution for posterior occlusal plane discrepancies.

After the position of the maxillary central incisal edges have been determined, then the incisal edges of the maxillary lateral incisors and canines, as well as the buccal cusps of the maxillary premolars and molars can be established (see Fig. 2). The levels of these teeth generally are determined by their esthetic relationship to the lower lip when the patient smiles [23,24]. If the patient has an asymmetric lower lip, then it may be more prudent to use the interpupillary line as a guide in establishing the posterior occlusal plane [25].

Fig. 3 (*continued*)

Determining the gingival levels

The next step in the process of determining the esthetic relationship of the maxillary anterior teeth is to establish the gingival levels. The current gingival levels should be assessed relative to the projected incisal edge position. The key to determining the correct gingival levels is to determine the desired tooth size relative to the projected incisal edge position (see Figs. 1, 2, 5, and 6). Remember that the incisal edge is not positioned to create the correct tooth size relative to the gingival margin levels. Using the gingiva as a reference to position the incisal edges is risky because gingiva can move with eruption or recession. So, the ideal gingival levels are determined by establishing the correct width-to-length ratio of the maxillary anterior teeth [26–28], by determining the desired amount of gingival display [15], and by establishing symmetry between right and left sides of the maxillary dental arch [18].

If the existing gingival levels will produce a tooth that is too short relative to the projected incisal edge position, then the gingival margins must be moved apically (see Figs. 1, 3, 5, and 6). This adjustment can either be accomplished with gingival or osseous surgery [29,30], through orthodontic intrusion [11], or with orthodontic intrusion and restoration [31–33]. The key factors that determine the most appropriate method of correction include the sulcus depth, the location of the cementoenamel junction relative to the bone level, the amount of existing tooth structure, the root-to-crown ratio, and the shape of the root [34]. In some situations, it is more appropriate to surgically crown-lengthen the maxillary incisors

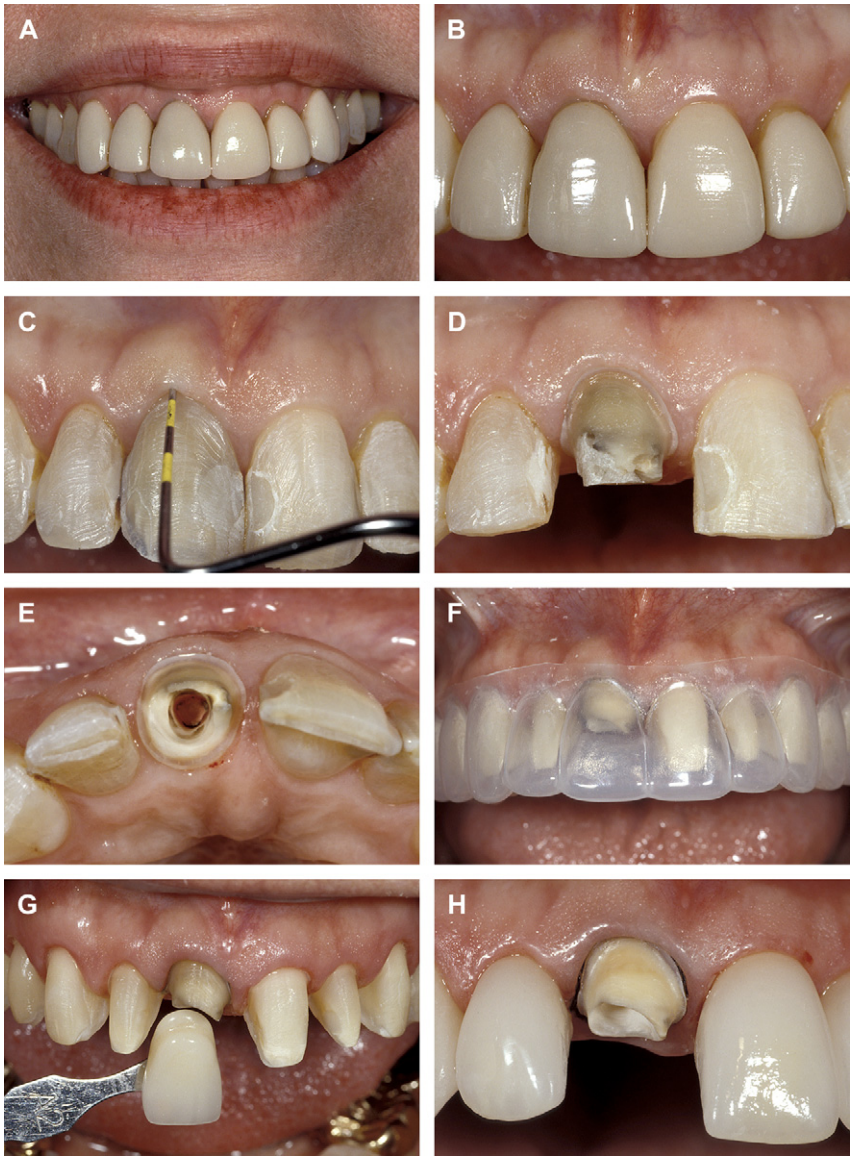

Fig. 4. This adult female was unhappy with the esthetics of her smile (*A*). The maxillary right central incisor had a nonvital pulp, and the root was dark (*B*). Her previous veneers were removed, and the tissue was probed over the maxillary right central incisor (*C*). After preparing the teeth, the right central incisor was very short (*D*), and the access opening for root-canal therapy was large (*E*), jeopardizing the structure of the teeth and the future restoration. The stent showed that preparation was adequate (*F*), and a shade guide was used to select the appropriate tooth color (*G*). The root fragment was bleached (*H*), and a post and coping was placed on the short tooth (*I*). The laboratory cast shows the extent of the restorations (*J*), and the size and shape of the crowns (*K*) and the esthetics of her smile (*L*) are improved.

Fig. 4 (*continued*)

(see Fig. 1) to establish the correct gingival levels [10]. In other situations, orthodontic intrusion (see Fig. 5) and restoration of the incisal edge is more appropriate [34].

The next step in the process of establishing the correct esthetic position of the maxillary anterior teeth is to assess the papilla levels relative to the overall crown length of the maxillary central incisors. Research has shown that the average ratio is about 50% contact and 50% papilla [35]. If the contact is significantly shorter than the papilla (see Figs. 5 and 6), then moderate to significant incisor abrasion is likely, which tends to shorten the crowns and therefore shorten the contact between the central incisors [30]. If the contact is significantly longer than the papilla, then perhaps the gingival contour or scallop over the central incisors is flat (see Fig. 1), which could be caused by altered passive or altered active eruption of the teeth [36]. Either gingival or osseous surgery [10] or orthodontic intrusion [13] or extrusion [34] may be necessary to correct the level of the papillae between the maxillary anterior teeth.

Arrangement, contour, and shade

At this stage, the incisal edge position, the midline, the axial inclination, the gingival margins, and the papilla levels of the maxillary anterior teeth have been established. The next step is to determine if the arrangement of the maxillary anterior teeth can be accomplished restoratively. If not, will

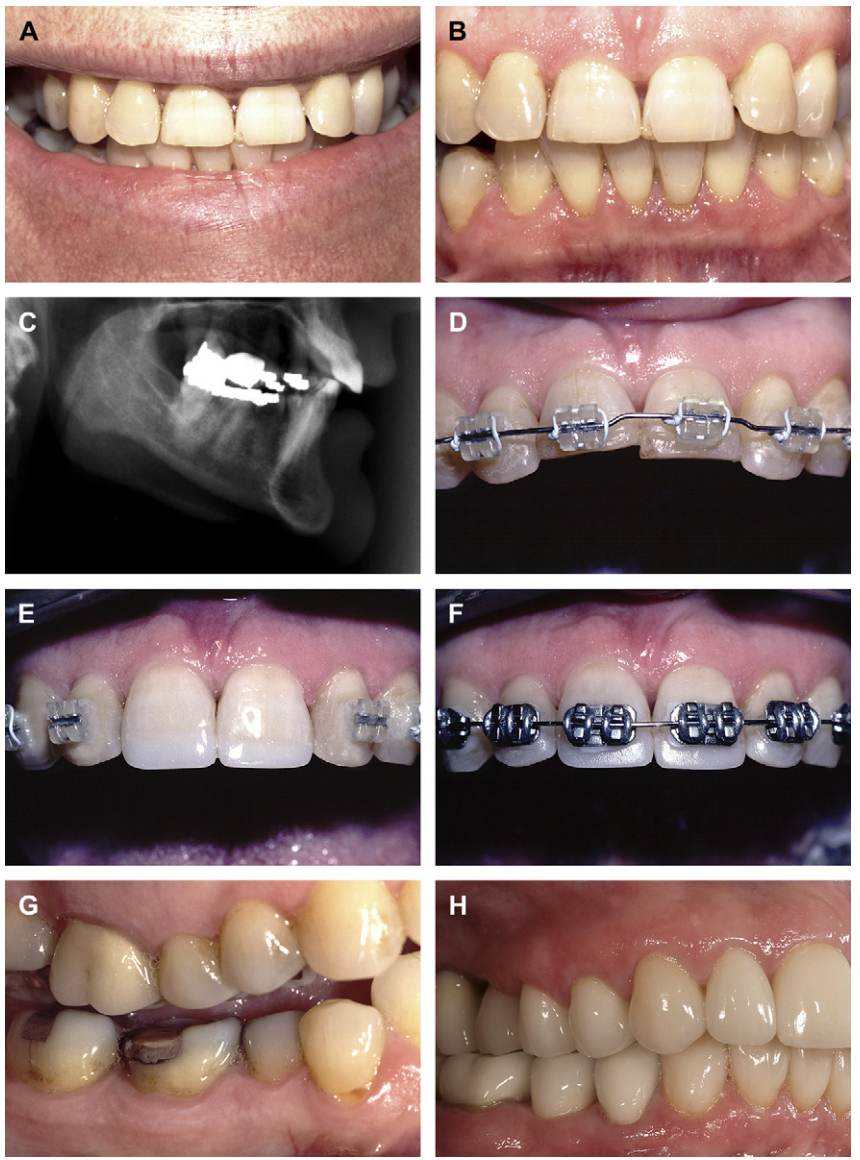

Fig. 5. (A–L) This adult female was unhappy with the appearance of her smile (*A*) and wanted longer maxillary anterior teeth (*B*). She had abraded her maxillary incisors, which had erupted to compensate and appeared short. The position of the maxillary incisal edge relative to the upper lip at rest was acceptable (*C*). Orthodontics was used to intrude the maxillary incisors (*D*) to move the gingival margins apically and provisionalize the teeth at a more attractive width-to-length proportion (*E*). Brackets were replaced on the maxillary incisors to stabilize them in their intruded position (*F*). Her posterior occlusion was improved during orthodontics (*G* and *H*) and her mandibular incisors were proclined labially to create coupling of the maxillary and mandibular anterior teeth during function. Space was opened to replace missing posterior teeth (*J* and *K*) and the esthetic appearance of her final restorations has been improved dramatically with interdisciplinary treatment (*L*).

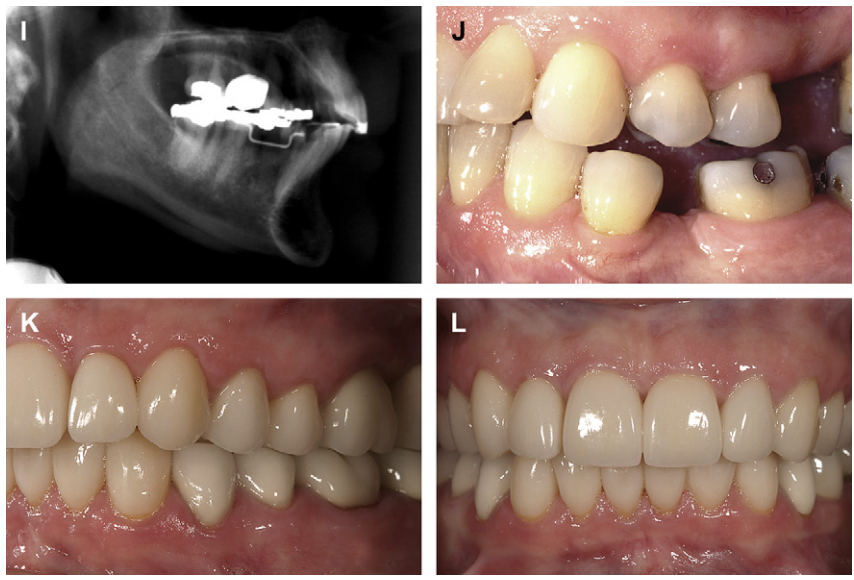

Fig. 5 (*continued*)

the patient require orthodontics to facilitate restoration? If in doubt, the clinician should perform a diagnostic wax-up (see Fig. 2) to confirm whether or not the arrangement is possible restoratively [18,34,37]. In addition, the contour and shade of the anterior teeth must be addressed. Does the patient have any specific requests concerning tooth shape or tooth shade? Remember, the more alterations made in these parameters, the more teeth will be treated, and the more involved the treatment plan will become. A good guide to esthetic treatment planning is to determine the ideal endpoint of treatment. Then compare it to the patient's current condition. Treatment is indicated when the desired endpoint and the current condition do not match. The actual method of treatment can then be chosen based upon the magnitude of the difference.

Develop the esthetic plan for the mandibular teeth

Now that the esthetic relationship of the maxillary incisors has been established, a proper relationship must be established between the mandibular incisors and the maxillary tooth position. First, evaluate the level of the mandibular incisal edges relative to the face. Do they have acceptable display, excessive display, or are they not visible? If they have excessive display, either equilibration, restoration, or orthodontic intrusion are possible methods of correcting the problem [34]. If they are not visible, either restoration or orthodontic extrusion may be necessary [38,39]. Next, determine

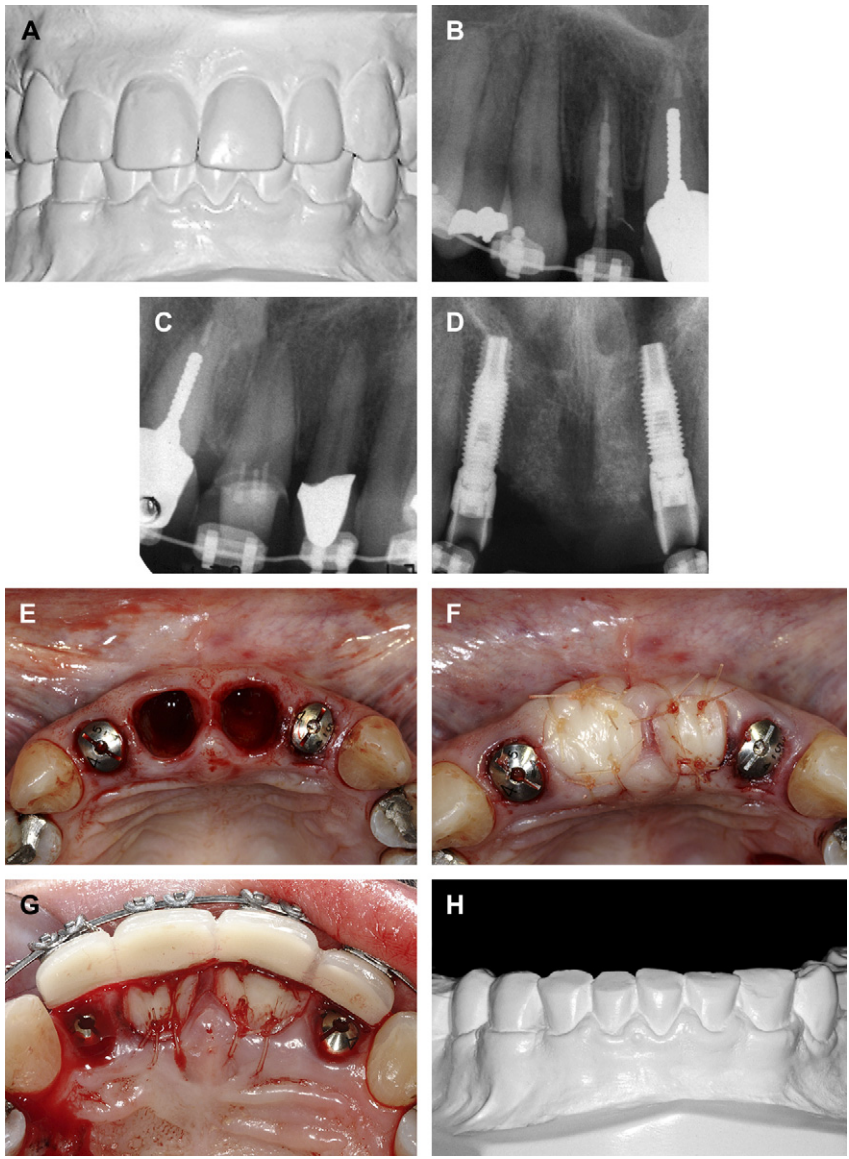

Fig. 6. This adult had short, worn, and hopeless maxillary incisors (*A*). Some of the teeth had failing root-canal therapy, and there was insufficient tooth structure remaining to restore these teeth (*B* and *C*). The maxillary central and lateral incisors were extracted and implants were placed in the lateral incisor positions (*D* and *E*). Tissue grafting was performed in the sockets of the extracted centrals to prepare the area for pontics (*F*). Since the orthodontic therapy was proceeding concurrently, a maxillary prosthesis was attached with brackets to the remaining teeth for esthetics (*G*). The mandibular incisors were abraded and had overerupted (*H*). These teeth were intruded nearly 3 mm (*I* and *J*) to avoid further reduction in height of these teeth during crown preparation. After the lower incisors were provisionalized with composite, brackets were replaced to stabilize tooth position (*K*). With adjunctive orthodontics, periodontics, implants, and coordinated therapy for this patient, the esthetics of her dentition and her occlusion were greatly improved (*L* and *M*).

Fig. 6 (*continued*)

the relationship of the mandibular incisors relative to the posterior occlusal plane. Are the incisors level with the posterior occlusal plane? If not, then they are either coronal or apical to the posterior occlusal plane. Correcting either of these relationships could require restoration, equilibration, or orthodontics (see Fig. 6) [4]. Finally, the labiolingual inclination of the mandibular incisors must be evaluated. This relationship is partially determined by the projected position of the maxillary incisors. If the inclination is either proclined or retroclined (see Fig. 5), orthodontics could be a useful adjunct in adjusting the labiolingual position of the mandibular incisors [34]. The final mandibular incisal edge position is usually determined during the functional and structural phases of the treatment planning (see Figs. 5 and 6).

The gingival levels of the mandibular dentition may need to change when the different options for leveling the mandibular occlusal plane are considered. If orthodontics is selected to either intrude (see Fig. 6) or extrude teeth, the gingival margins move with the teeth [40]. However, if equilibration or

restoration is necessary to level the mandibular occlusal plane, then the gingival levels may need to be relocated with osseous surgery [10].

At this point, based upon the esthetic determination of the projected positions of the maxillary and mandibular teeth, the clinician should be able to determine which teeth need restoration [41] (ie, the maxillary anteriors, maxillary posteriors, mandibular anteriors, or mandibular posteriors). Then, once the maxillary and mandibular occlusal planes have been established through esthetic parameters, the clinician must determine how to create an acceptable occlusal relationship between the arches.

Steps to integrating function and esthetics

The first step to integrating the esthetic plan with the functioning occlusion is to evaluate the temporomandibular joints and muscles [42]. Does the patient have any joint or muscle symptoms? A key step in the process is to make centric relation records and mount the models. Our definition of centric relation is the position of the condyles when the lateral pterygoid muscles are relaxed and the elevator muscles contact with the properly aligned disk [42]. The question that the clinician must ask is whether or not the desired esthetic changes can be made without altering the occlusion. If not, orthodontics or orthognathic surgery may be required to correct tooth position to facilitate the esthetic positioning of the teeth. To determine the impact of the esthetic plan on the function or occlusion, the esthetic changes in maxillary tooth position must be transferred to the maxillary dental cast [42]. This is accomplished with an application of wax in combination with an adjustment of the plaster casts (see Fig. 2).

As the proposed esthetic treatment plan is transferred to the mounted casts, the clinician can determine if restoration alone will accomplish the desired occlusion, or if alteration of the occlusal scheme through orthodontics or orthognathic surgery will be necessary. This is especially true when the clinician is planning to level the occlusal planes. A key question to ask is whether leveling of the occlusal planes creates an acceptable anterior dental relationship. If the answer is yes, and the leveling involves only the mandibular incisors, then the patient's existing vertical dimension can be maintained. If, however, the answer is no or the leveling involved mandibular posterior teeth, the existing vertical dimension may need to be altered. The clinician must determine whether altering the vertical dimension will result in acceptable tooth form and anterior relationships. There is no replacement for mounted dental casts and a diagnostic wax-up when these critical questions are being addressed.

Determine if adequate structure exists to restore teeth

Once the esthetic treatment plan has been established, the projected tooth position has been verified on the diagnostic wax-up, and the functional

relationships of the mounted dental casts has been assessed, the clinician must determine if adequate tooth structure exists to restore the teeth. If not, how will the clinician obtain adequate structure? What types of restorations will be placed? How will they be retained? How will any missing teeth be replaced? Based upon the clinician's assessment of the remaining tooth structure [41], the choices for restoring anterior teeth could include composite bonding, porcelain veneers, bonded all-ceramic crowns, luted all-ceramic crowns, or metal ceramic crowns (see Figs. 1, 2, 4–6). The posterior restorations could include direct restorations, inlays, onlays, or crowns. If teeth are missing, they will either be replaced with implants, fixed partial dentures, or removable partial dentures. The evaluation criteria to determine which restorations are appropriate include (1) the current clinical crown length, (2) the crown length after any gingival changes are performed for esthetics, (3) current amount of ferrule [40], (4) the space available for a build-up, and (5) the effects on esthetics of any crown lengthening for structural purposes. The methods for increasing the retention of restorations are the build-up method, surgical crown lengthening [10], orthodontic forced eruption [33,40], and restorative bonding. Each clinical situation must be carefully evaluated to determine the appropriate structural solution.

Biology: last but certainly not least

The esthetic plan has been established. The diagnostic wax-up confirms that the teeth will function properly. The restorative plan has taken into consideration the existing tooth structure. Now is the time to add the biologic aspects of the treatment plan. The biologic aspects include endodontics, periodontics, and orthognathic surgery. The primary objective of biologic treatment planning is to establish a healthy oral environment with the tissue in the desired location. To accomplish this objective, endodontics may be necessary for teeth that are structurally and periodontally salvageable. In these cases, the endodontic therapy must be completed first, before beginning the restorative phase of dentistry. The definitive periodontal therapy must be established to create a healthy periodontium based upon the esthetic, functional, and structural needs of the restorations. Any elective periodontics must be completed next, in conjunction with the restorative plan. Finally, if there are any skeletal abnormalities that require orthognathic surgical correction, these must be accomplished before the definitive restorative phase of treatment.

Sequencing the therapy

The plan is complete. It began with esthetics, it was correlated to function, it took into consideration the remaining tooth structure, and it was facilitated by recognition of the biologic needs of the patient. The only two questions that remain are: (1) How should this esthetically based treatment plan be

sequenced? and (2) Can the patient afford the treatment? The sequence of any treatment plan should always begin with the management or alleviation of acute problems. Then the remaining treatment plan can be sequenced in a manner that seems the most logical and facilitates the next or following phase of treatment, provided the result can be clearly identified, communicated, and achieved for the pertinent phase. When we establish the sequence of treatment for an interdisciplinary patient, we list the steps in the treatment plan based upon our collective opinion before the beginning of treatment [34,37]. Every member of the team receives a copy of the treatment sequence. This step ensures that each member of the team is able to follow the steps in the esthetic, functional, structural, and biologic rehabilitation of our mutual dental patient.

The economics of the interdisciplinary esthetic treatment plan is obviously of primary importance. To aid in this evaluation, it is useful to sort patients in four categories, as described in a previous article [43]. Type-I and -II patients generally do not require significant esthetic restoration. However, types III and IV typically require the type of esthetic evaluation that we have outlined in this article. The type-III patient is a healthy adult with no occlusal disease and no periodontal problems, but a desire for an esthetic change (see Figs. 1, 3, and 4). The type-III patient could be described as the cosmetic patient who is dentally healthy, but wishes to make a change in appearance. The hallmark of treating the true cosmetic patient is the requirement of time on the part of the dentist. The dentist must realize this commitment and charge a commensurate fee. The most challenging situation is the type-IV patient (see Figs. 2, 5, and 6), whom we have outlined in this article. This is an adult whose dentition is failing, may have occlusal disease, periodontal disease, multiple restorative needs, and missing teeth. The type-IV patient is the complex reconstruction patient in any dental practice. The hallmark of this patient is multiple appointments over months or even years, depending upon his or her orthodontic, periodontal, endodontic, surgical, and restorative needs. Due to the increased number of appointments and lab fees, the clinician must adjust the fees to reflect the amount of time commitment. For ideas on establishing appropriate fees in these types of patients, the reader is referred to this previous article [43].

Summary

Esthetics has become a respectable term in dentistry. In the past, the importance of esthetics was discounted in favor of terms such as function, structure, and biology. However, if a treatment plan does not begin with a clear view of its esthetic impact on the patient, then the outcome could be disastrous. In today's interdisciplinary dental world, treatment planning must begin with well-defined esthetic objectives. By beginning with esthetics, and taking into consideration the impact on function, structure, and biology, the clinician can use the various disciplines in dentistry to deliver

the highest level of dental care to each patient. It really works. We call this process interdisciplinary esthetic dentistry.

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