Orthognathic Surgery Versus Orthodontic Camouflage in the Treatment of Mandibular Deficiency

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Although there have been significant advances in the combined surgical and orthodontic treatment of patients with mandibular deficiency, many patients continue to be treated by orthodontics alone without consideration for surgical correction. The correction of Class II malocclusion due to mandibular deficiency can be accomplished in a variety of ways. Proffit and Akerman described three primary treatment approaches for correction of mandibular deficiency and the associated Class II malocclusion. These approaches include: 1) growth modification so that the jaw discrepancy is eliminated as a result of mandibular growth; 2) compensation of the dentition with retraction of the upper incisors and proclination of the lower incisors, or both, in an effort to camouflage rather than correct the skeletal problem; or 3) surgical correction of the jaw abnormality. In the case of mandibular deficiency, this is usually accomplished by mandibular advancement. A fourth option that could be considered includes orthodontic treatment of the malocclusion, compensating the dentition, combined with genioplasty. This option is intended to correct the malocclusion with orthodontic compensation and improve facial esthetics with a somewhat simpler surgical procedure.

Each of these treatment approaches is associated with controversy, including which patients benefit most from a specific treatment and the timing of treatment, particularly when considering growing patients.

During the past two decades correction of Class II malocclusions with surgical advancement of the mandible has improved dramatically. This is due in part to significant advances in technology, as well as increased experience on the part of both orthodontists and surgeons in treating mandibular deficiency. Both orthodontic and surgery residents generally get adequate exposure to patients receiving this type of treatment during their training.

The use of rigid fixation techniques, and the trend toward shorter inpatient hospital stays have dramatically decreased the impact of surgery on patients. Whereas 15 years ago patients frequently spent 2 nights and nearly 3 days in the hospital, patients now routinely stay only overnight to as little as a few hours in an outpatient surgical facility. Instead of having their teeth wired together for 6 to 8 weeks, patients routinely undergo mandibular advancement surgery with no maxillomandibular fixation. All of this results in more rapid recovery from surgery, earlier return to work, and much less disruption of the lives of patients and their families.

There do continue to be risks that are associated with surgery, including adverse outcomes such as neurosensory abnormalities, failure to achieve the anticipated occlusal result, nonunion, malunion, and the associated risks of general anesthesia. However, the low frequency and lack of severity of most complications has made surgical treatment much more commonplace in the correction of Class II malocclusions. Whereas surgical treatment was once viewed as a “last resort” reserved for those with the most severe abnormalities, it is now be considered a routine treatment for correction of mandibular deficiency in indicated cases.

Patient Evaluation

Much of the controversy related to treatment may actually result from each practitioner’s assessment of the clinical problem. A recent study documented significant disagreement between trained orthodontists and surgeons when evaluating patients with dentofacial deformities. The differences in assessment of the patient’s deformity included the specific nature of the
deformity, as well as the severity of the deformity. The differences in opinion regarding the severity of the deformity may be compounded by each practitioner's interest or focus on a specific component of the malocclusion, i.e., skeletal versus dental. In a study assessing patients who were evaluated for orthodontic and surgical treatment, Proffit et al found fewer Class II patients with severe overjet than with significant skeletal deficiency. This is probably due to significant dental compensation (lower incisor protrusion and upper incisor retraction) reducing the degree of dental abnormality despite a significant skeletal deformity. Focusing more on the occlusal relationship and less on the skeletal position may result in different treatment approaches than would be generated if more attention was placed on the skeletal component.

Most patients seek orthognathic surgical treatment based on the recommendation of the treating orthodontist. Because many orthodontists may not focus on the skeletal component of mandibular deficiency, or consider it severe enough to warrant treatment, many patients with Class II malocclusions may never receive a surgical consultation or have this treatment alternative discussed as a viable option.

At the present time there are no widely accepted guidelines, nor is there a "gold standard," for determining which cases of Class II malocclusion would best be treated with surgery versus orthodontic camouflage. Proffit and Akerman, have described the envelope of discrepancy, which can help serve as a guide when selecting appropriate treatment modalities for patients with a variety of maxillofacial abnormalities of varying severity. This envelope of discrepancy is based on the severity of the abnormal occlusal relationships (Fig 1). Using this concept, three asymmetric circles are used to help visualize the range of correction that can be accomplished by orthodontic tooth movement alone, a larger range of correction that can be accomplished by functional appliance therapy in combination with orthodontic treatment, and an even larger range of correction that uses surgery as part of the treatment. Using this concept, the outer limits of correction for each type of treatment can be clearly visualized. However, in this diagram, the limits of treatment are represented by a finite line separating each type of treatment. In actual clinical practice such strict division of patients into types of treatment cannot and does not occur. A variety of treatment options continues to exist for each patient based on his or her primary goals for treatment, as well as practitioner preference and experience.

**Patient Motivations for Treatment**

All medical and dental treatment should initially be based on the patient's chief complaint. In the case of patients who may be candidates for orthodontic and surgical treatment, there is a wide variety of chief complaints expressed by patients and significant differences in patient goals for outcomes of treatment. Patient's goals for treatment can include: 1) Enhanced dental esthetics; 2) Improved dental function; 3) Better facial esthetics; 4) Resolution or improvement of temporomandibular joint or muscle pain; and 5) Improved long-term maintenance of the dentition when factors such as periodontal problems are exacerbated by malocclusions. Each of these concerns must be prioritized by the patient, orthodontist, and surgeon to insure that the most important goals for the patient are achieved as a result of treatment.

The importance of facial esthetic improvement can-
not be underestimated in patients who are considering orthodontic and surgical treatment. In one study, a significant percentage of females (55%) and males (41%) indicated that esthetics and improvement in appearance were a major factor in their goal for seeking treatment. Flanary et al found that facial esthetics was of significant importance in 78% of patients electing to undergo orthodontic and surgical treatment.

When patients describe improvement in facial esthetics as a high priority goal for treatment, the exact nature of their concerns and goals must be carefully evaluated. Variation in patients’ evaluation of their own facial esthetics may eventually have a significant impact on the type of treatment. For instance, two patients may present with nearly identical facial appearance, a mild mandibular deficiency and Class II malocclusion. Each patient may list improvement in facial esthetics as a primary goal for seeking treatment. One patient may describe dentoalveolar protrusion as the primary facial abnormality. In many cases this will be amenable to orthodontic treatment only. On the other hand, a patient who describes deficiency in projection of the lower jaw as the facial abnormality, may be treated best with a combination of orthodontics and surgery.

Even when nearly identical clinical situations exist, some patients view their deformity as being much more severe than others. Bell et al found that patients who opted for surgical treatment were significantly less likely to perceive themselves to be in the normal range when evaluating their own profile. For this reason it is important to specifically identify this group of patients, so that the treatment plan can be aimed at addressing all of their concerns in order to achieve their goals for treatment in the best possible way.

Treatment Planning

The data collection and analysis for treatment planning of mandibular deficient patients are relatively standardized in both the orthodontic and surgical communities. Data collection includes a patient interview, clinical examination, radiographs, photographs, study models and, in some practices, computerized video imaging. The data analysis includes interpretation of cephalometric radiographic data, model analysis, and treatment projections using cephalometric prediction tracings and, in some cases, trial setup of occlusal models. The importance of each aspect of the decision-making process is well known, has been discussed in the companion article in this issue, and will not be discussed further in this article.

The use of video imaging has increased as a result of improved computer technology, decreased cost, more accurate imaging projection, and increased acceptance as a treatment-planning modality. In the absence of growth, tracings generated from cephalometric radiographs, can be used with reasonable accuracy to predict surgical outcome. However, it is extremely difficult for most patients to clearly understand the impact of treatment on facial esthetics when viewing cephalometric profile tracings. The recent use of video imaging has enhanced the patient’s ability to perceive projected surgical changes and make a more informed decision related to possible treatment options.

It is obvious that patients with nearly identical mandibular deficiency and Class II malocclusions will have dramatic differences in facial appearance as a result of orthodontic versus surgical treatment. Variations in orthodontic treatment options can also produce marked differences in facial profile. Paquette et al described differences in facial profile as a result of correction of Class II malocclusions with or without extraction. Although they are not as dramatic as changes sometimes seen with surgical treatment, facial profile changes as a result of various orthodontic options may also be of significant importance to patients. The ability to show patients the effect on the facial profile of both orthodontic and surgical treatment options provides better information regarding treatment outcome. This allows patients to interact and participate in their own treatment planning by providing an assessment of their own perception of facial esthetic changes (Fig 2). At the present time the computerization of predicted changes is limited to two-dimensional images. In the future, computer technology will most likely provide the ability to generate predicted facial images in three dimensions.

Efficacy of Surgical Treatment

The efficacy of treatment can be judged using a variety of parameters including improvement in occlusal characteristics such as overbite, overjet, and buccal interdigitation, and improvement in facial esthetics and long-term stability. Very few studies have been designed that directly compare similar homogeneous populations of patients divided into surgical and orthodontic treatment groups. Profitt et al compared outcomes of orthodontic and surgical orthodontic treatment of Class II malocclusions in 57 adult patients treated for similar occlusal and skeletal problems using cephalometric data and dental casts to evaluate the relative success of treatment. The outcome of each individual treatment was evaluated in two separate ways. First, the result was judged based on whether the final measurement of a particular result of treatment fell within a normal range. In this study acceptable results were similar in both groups when evaluating overbite and buccal interdigitation. However, there were two obvious differences between the surgical and orthodontic groups: in the surgical group acceptable
overjet was achieved in 95% of cases versus 74% in the orthodontic treatment group, and an acceptable ANB difference was achieved in 81% of the surgical patients versus 52% of patients who received only orthodontic treatment.

In the same study, the efficacy of treatment was also measured by evaluating the actual change occurring in a measurement after treatment expressed as a percentage of the change needed to give an ideal post-treatment value. The closer a post-treatment value was to 100% of the ideal, the more “successful” the treatment. When evaluating treatment efficacy in this manner, a significantly greater percentage of the ideal goal was achieved in surgery patients when evaluating the skeletal ANB difference, soft tissue AB difference, the location of the maxillary incisor, and overjet. The percentage differences of the goals achieved for overjet and ANB difference are shown in Figures 3 and 4.

Patients with mandibular deficiency who undergo orthodontic and surgical correction have greater improvement in facial esthetics when compared with patients undergoing orthodontic treatment only. In the Proffit et al. study previously described, the esthetic outcomes of patients were evaluated by orthodontists and surgeons, comparing orthodontic only treatment with surgical advancement of the mandible in combination with orthodontic treatment. There was no significant disparity between the opinions of orthodontists and surgeons when evaluating these patients. The esthetic changes from orthodontic treatment only appeared to be small and the changes were as likely to be negative as positive (Fig 5A). However, the surgical

FIGURE 2. Video imaging treatment options. A, Pretreatment photograph. B, Cephalometric superimposition showing pretreatment profile and results obtained with orthodontic treatment only (extraction of upper and lower premolar teeth) and with surgical treatment. C, Video image of orthodontic only treatment plan. D, Video image of surgical treatment plan.
group had significant improvement in esthetic ratings for 11 of 13 patients (Fig 5B). As would be expected, the improvement appeared to be greatest in patients with the lowest pretreatment ratings. Although the esthetic changes were evaluated by orthodontists and surgeons who may evaluate these features more critically, it has been shown that the lay public can also detect changes in facial esthetics as a result of surgical treatment. In a study by Dunlevy et al. there was general agreement among laypersons, orthodontists, and oral and maxillofacial surgeons when asked to evaluate patients' improvement in facial appearance after orthognathic surgery.

It has also been shown that patients undergoing orthognathic surgical treatment experience greater improvement in facial body image scores when compared with patients undergoing orthodontic treatment only or patients who decline any type of treatment whatsoever (Fig 6). As with professionals' judgement of facial esthetics, overall body image and facial image appear to be lowest at the initial assessment for patients who elect to undergo surgery, when compared with patients undergoing orthodontic treatment only. Over the time of treatment there is some improvement, but this is less in patients receiving orthodontic treatment only than in those undergoing surgical correction.

**Special Considerations in Adolescents**

Unlike adult patients, developing adolescents will continue to have some facial growth, which can play a part in treating Class II malocclusions. In a recent study, surgical versus orthodontic treatment of Class II malocclusions was evaluated in adolescent patients. In this study three groups were identified: those treated successfully with orthodontics alone, those treated with orthodontic and surgical correction, and those whose orthodontic treatment was judged to be unsuccessful. In this study, successful orthodontic treatment resulted from a combination of retraction of the maxillary incisors and protraction of the mandibular incisors in combination with some continued facial growth. Forty percent of these patients had greater than 2 mm of anterior-posterior growth during the treatment period. The unsuccessful treatment group initially had greater overjet, more severe mandibular deficiency, increased anterior facial height, and less retraction of maxillary incisors and less growth during treatment. The recommendation of this study was that in Class II adolescents who are beyond the growth spurt, surgery is most likely to be needed for successful correction of the malocclusion if the overjet is greater than 10 mm, if the distance from pogonion to nasion perpendicular is 18 mm or more, if mandibular body length is less than 70 mm, or if facial height is greater than 125 mm.

**Other Considerations**

In addition to the functional, occlusal, and facial esthetic considerations, several other factors must be considered when developing a treatment plan for correction of Class II mandibular deficient malocclusions. Patient compliance may be a significant factor in the outcome of any type of treatment. Some types of treatment require much more compliance or participation on the part of the patient to achieve the desired goal. Maxillary retraction dependent on use of a headgear is an important part of orthodontic treatment to eliminate overjet in many patients. Headgear must be worn consistently and for the appropriate amount of time each day to maximize the effect of this type of treatment. Patients who are unable or unwilling to

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**Figure 3.** Graphic representation of the percentage of an ideal goal for overjet correction achieved as the result of orthodontics only and surgical and orthodontic treatment. (Reprinted with permission.)

**Figure 4.** Percentage of ideal goal for ANB correction achieved as a result of orthodontics only or orthodontic-surgical treatment. (Reprinted with permission.)
comply with this type of treatment are less likely to achieve the treatment goals. In many cases, patients would prefer to undergo surgical correction as opposed to committing themselves to participation in headgear therapy.

Patients undergoing orthodontic treatment alone may be in treatment for shorter periods than patients undergoing surgery in combination with orthodontics. There are however, several situations where a combined orthodontic-surgical therapy may decrease treatment time. An example would be when orthodontic treatment only will require extractions and space closure as part of the orthodontic camouflage therapy. The same patient might be treated quicker without extraction, allowing for surgery at an earlier time in treatment followed by final orthodontic detailing.

The risks of surgery must always be considered and balanced against the benefits of surgical treatment. Surgery will always be associated with some pain, swelling, and the possibility of intraoperative or postoperative bleeding. Other long-term complications such as neurosensory abnormality, nonunion, malunion, postoperative malocclusion, and relapse must also be considered. Current technology and practitioner experience have greatly reduced the complications resulting from this type of treatment and increased the level acceptance by patients and orthodontists. When providing patients with information regarding surgical treatment, it is important to make it as accurate as possible. In some cases this can be provided by an orthodontist with wide experience with surgical patients who is familiar with all aspects of surgical treatment; however, in most cases, this information is best provided by an oral and maxillofacial surgeon who routinely performs the procedure.

As a part of informed consent, patients should also be counseled about alternative treatments and the risks and benefits associated with each of these alternatives. While, in general, orthodontic treatment may be perceived as less risky than surgical treatment, there are occasions where certain problems may occur as the result of orthodontic treatment that may be less likely to happen with orthodontic treatment in combination with surgical correction. One example would be the possibility of severe resorption of maxillary incisor roots resulting from retraction during orthodontic camouflage treatment. Kaley et al recently described a 20 times greater risk of resorption in maxillary incisor roots when they are torqued against the palatal cortical plate, the exact movement required when retracting maxillary incisors in correction of Class II malocclusions.

The current medicolegal environment requires that patients be fully counseled regarding all of their alternatives for treatment of a specific problem. When surgeons discuss the possibility of surgical treatment of mandibular deficiency it is imperative that they

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FIGURE 5. Esthetic ratings before and after treatment. A. The orthodontics-only patients started at a slightly higher level than patients undergoing orthodontic and surgical treatment. B. Surgical patients had greater increase in facial esthetic ratings as a result of treatment. (Adapted with permission.)

FIGURE 6. Facial body-image scores for patients undergoing surgical-orthodontic treatment, orthodontics only, and no treatment. (Reprinted with permission.)
also discuss the possibilities of no treatment and orthodontic treatment only, presenting their assessment of the advantages and disadvantages of each treatment. Orthodontists discussing correction of Class II malocclusion and mandibular deficiency should also present the possibility of surgical treatment to the patient along with a realistic assessment of the risks and benefits and projected outcome of each type of treatment. Failure to provide adequate information that would allow the patient to make an informed decision regarding type of treatment may have medicolegal implications if the patient is not satisfied with the outcome of treatment.

Finances appear to be one of the disadvantageous factors when a patient is considering surgery as part of the corrective treatment for a Class II malocclusion. Because surgery requires operating room time, a same-day admission or overnight hospital stay, and anesthesia and other ancillary fees in addition to the surgical fee, this obviously increases the cost of treatment. The effect of decreased third-party payment for this type of surgical treatment has become a major factor in influencing many patients to elect nonsurgical treatment. Although surgical treatment will always increase the cost to some degree, efforts to reduce operating time and hospitalization have resulted in significant cost reduction. Further efforts in this regard will hopefully ease the financial burden associated with surgical treatment.

Summary

Surgical correction of Class II malocclusions, when associated with mandibular deficiency, often has improved results with combined orthodontic and surgical correction compared with orthodontic treatment alone. Strong consideration of surgical correction of mandibular deficiency should be based on the following questions:

1) Do the patient’s goals for treatment place a high priority on improvement in facial esthetics? As a corollary, even patients who are not particularly concerned with facial esthetics, but who may have a worsening in facial appearance as a result of orthodontic camouflage, should be considered for surgical correction. This may include patients with lack of upper lip support, an obtuse nasolabial angle, a large nose, and a long lower face height, all of which may become more apparent as a result of orthodontic camouflage treatment.

2) Are the orthodontic movements required in excess of the envelope of discrepancy so that adequate orthodontic correction may not be achieved?

3) Could orthodontic-surgical treatment result in a significant decrease in treatment time? An example would be when surgical treatment in combination with orthodontics could be accomplished without extraction, whereas orthodontic treatment alone would require extraction and space closure.

4) Is there adequate patient compliance? Would orthodontic treatment alone be as ineffective without adequate patient cooperation?

5) Are the risks of surgery within acceptable levels? Are the benefits of surgical treatment, as previously described, obvious?

References