Relapse after Total Mandibular Advancement: A Possible Solution

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In recent years interest in orthognathic surgical correction of facial deformities has become more and more prevalent. Orthodontists and surgeons have become more concerned with the long-term results of these procedures. The literature shows that in spite of accurate location of the occlusion at time of surgery and regardless of what techniques are used and what special postoperative precautions and procedures are taken, an appreciable number of patients undergoing correction of these deformities suffer varying degrees of postoperative relapse.

When Obwegeser presented the many facets of European orthognathic surgery in this country in the late 1960's, he focused the attention of American orthodontists and surgeons on the infinite number of treatment possibilities for improving severe facial deformities.

In no area of dentofacial deformity is it more difficult to achieve successful and stable treatment results than in mandibular advancement for correction of Class II malocclusion. To complicate matters it is obvious that Class II malocclusion occurs with greater frequency than any other facial deformity.

Because of Obwegeser's impact a great percentage of these deformities were and are treated by advancement of the mandible in conjunction with orthodontic procedures, unfortunately, not without a significant percentage of skeletal and dental relapse.

A cursory review of the current literature reveals that several authors comment on relapse from a relatively small number of cases or from records from which it is difficult to draw valid conclusions.

Poulton and Ware,[1] as well as Proffit and White,[2] emphasize the overriding importance of orthodontist-oral surgeon cooperation in the diagnosis, planning, and eventual treatment of patients with mandibular retrognathism. The first mentioned authors reported on two Class II cases in which presurgical orthodontic therapy was followed by sagittal osteotomy to move the mandible forward. They discussed the special problem of the deficient mandible related to the number of muscles attached to it, particularly the suprahyoid group, which is lengthened when the mandible is repositioned anteriorly and caution that the pull of this muscle would work toward posterior relapse. They also mentioned the overemphasis placed on the relapse potential from the major muscles of mastication.

These authors as well as Wickwire et al.[3] mention that any repositioning of the mandible in Class III cases will result in a downward and forward change of position of the hyoid bone and associated musculature to protect the airway while the change is upward and forward in Class II cases. The upward and forward position of the hyoid was viewed as another indication of muscle tension. Long term follow-up shows that the hyoid returns close to its original position. There is some degree of skeletal relapse in mandibular position associated with this, but not 100 percent. This would indicate that some slight degree of permanent lengthening of the suprahyoid muscles does occur, as indicated by Poulton and Ware. Wickwire and associates advocate, however, myotomy of the genio-

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hyoid muscle while discounting the role of the pterygomasseteric sling in relapse.

In an attempt to preclude posterior relapse, which appears to be accepted to some degree as inevitable, Poulton and Ware recommend:

1. Overrotation of the mandible by 12 to 15 degrees, bringing the chin upward and forward, which is done by using a thick occlusal splint in the molar region and overcorrecting forward.

2. Use of metallic bone implants to quantitate relapse tendencies.

3. Use of a postsurgical lip bumper as a prosthetic device to lessen the effect of a tight lower lip. They also recommend the use of a shoulder brace modified from the upper portion of a Milwaukee brace called a Pitkin collar as an effective aid in minimizing skeletal relapse.

Myotomy of the anterior belly of the digastric, mylohyoid, genioglossus, and geniohyoid muscles was mentioned as a solution, but abandoned as a threat to the patient's airway.

Proffit and White caution that relapse after surgical-orthodontic therapy can be avoided by eliminating, where possible, the causes contributing to the original malocclusion and by not operating while patients are still growing.

A recently published study on skeletal relapse during intermaxillary fixation by McNeil et al.[4] presents four complex Class II cases: two Class II, Division 1 cases and two cases of apertognathia, qualified as severe. These authors emphasize that dental structures used for intermaxillary fixation following osteotomies are not the stable bases they were thought to be and that, while teeth are examined in occlusion during fixation, concomitant skeletal relapse and tooth movements can and do take place during fixation.

They confirmed reports of skeletal relapse following mandibular advancement and agreed that this occurred during fixation. They believed that the active force of the lengthened anterior mandibular musculature was responsible for the alteration seen skeletally and in the dentition.

McNeil et al. further mentioned that compensation for some of the above predictable changes could be accomplished through preoperative orthodontic retraction of the mandibular incisors and/or use of counterclockwise overrotation of the mandible and an interocclusal wafer to open the bite posteriorly. They also concurred with Poulton and Ware that a form of anterior-positioning extraoral traction delivered through a modified shoulder-sternal brace would be helpful in preventing relapse. They concluded that modification in surgical technique and improved fixation methods would eliminate the presently observed relapses. Serial cephalometric films were recommended to ascertain relapse in progress and when to terminate fixation.

In a study done by Farrell and Kent[5] specifically evaluating the effect of two types of surgical procedures on the long-term stability of the correction, similar results regarding relapse were demonstrated and similar concerns were expressed. The authors indicate the inverted L and C osteotomies, when used to correct the deformities of mandibular retrognathism and open bite, are susceptible to some degree of relapse.

Examination of those cases corrected with the inverted L osteotomy showed that the decrease in anterior facial height and increase in posterior facial height were not stable. Some degree of relapse occurred, the majority during the first 6 months postoperatively. An average relapse of 31 percent in anterior facial height and 5 percent in posterior facial height was reported.

An average relapse of 23 percent of the amount of mandibular advancement obtained with the C osteotomy was found in this same study. Comparable results were reported by Poulton and Ware when the neck brace was used in the postoperative period.

Farrell and Kent write that, while numerous authors have examined orthognathic surgical results and pointed to the importance of altered muscle patterns on long-term stability, the effect of the major muscles of mastication is eliminated by the design of the inverted L and C osteotomies. The sphenomandibular and stylohyoid ligaments have also been indicated by the authors as possibly responsible for restricting mandibular advancement and any increase in posterior facial height. The suprahyoid muscle group is considered by these authors as possibly the main force contributing to skeletal relapse in the correction of both mandibular retrognathism and open bite.

Suprahyoid myotomy was performed in only two of the twenty cases studied by Farrell and Kent with apparently improved stability during the postoperative period. They indicate that further experience with this procedure may show that suprahyoid myotomy will significantly reduce the degree of relapse.

In another attempt to minimize the relatively high rate of relapse following surgical correction of Class II and open bite, numerous authors[6,7,8] have suggested the use of posterior maxillary ostectomy or combined anterior and posterior maxillary ostectomies as the surgical procedure of choice. Ostensibly, this choice is based in part on the differential diagnosis of the problem or the location of the greatest anatomical deviation from normal.

Theberge[9] emphasized that in treatment of dentofacial abnormalities the focus of corrective attack should be the point of greatest abnormality, thereby implying the need for great care in differential diagnosis. Precise determination of all disharmonies rests on three modalities: clinical evaluation, cephalometric analysis and model study. These three facets have been previously stressed by numerous other authors.

If one would retreat from the literature for a moment he might come to the conclusion that "differential diagnosis" is one of the most often misused and abused terms encountered in what is supposed to be a scientifically-founded and biologically-based field. Indeed, it appears more often than not that a differential diagnosis and a treatment plan are based on: first, artistic or subjective interpretations of biologic manifestations; second, an individual's personal experience and expertise with a particular mechanical approach or surgical technique; and third, an author's blurred intent upon rationalizing the reasons for apparent success with a "new" approach.

To test that somewhat disturbing concern the pretreatment records (Fig. 1) of a 22 year old female were sent to three teams consisting of an orthodontist and a surgeon considered, because of their work and extensive contributions to the literature in this area, to be somewhat expert on the subject.

Esthetic evaluation of this individual revealed an extremely retrognathic facial profile and severe maxillomandibular dysplasia, often described in the literature as "Vogelgesicht" or "Bird Face." The lips were apart at rest and the upper lip appeared extremely hypertonic and elongated. All of the musculature of the lower face and suprahyoid region appeared underdeveloped and hypertonic.

A clinical functional examination indicated a suboptimal range of mandiblar movements with a "hyoid-type" of opening beyond the initial opening

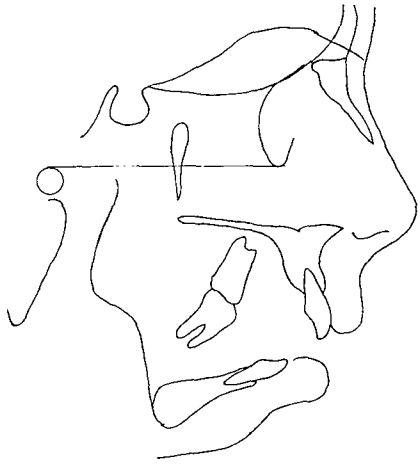


Fig. 1

movements (rotation of the head posteriorly around the cervical vertebrae while fixing the mandible with the suprahyoid musculature). Further evaluation showed that opening, closing and lateral movements of the mandible could be accomplished without gross cranial movement.

Panoramic radiographic evaluation revealed nearly total absence of both condyles, while the lateral cephalometric tracing indicated the severity of the Class II open bite with an ANB angle of 14.5° and a mandibular plane angle of 87°.

After viewing these records, the first team suggested bilateral posterior maxillary ostectomies with superior positioning of the segments as the surgical procedure to close the bite and correct the Class II relationship. This was based on the "differential diagnosis" of posterior maxillary alveolar hyperplasia and would allow for correction of the vertical and anteroposterior problem through counterclockwise rotation of the mandible. A sliding symphyseal osteotomy and detachment of the suprahyoid muscles would be necessary to complete the correction.

The second team suggested bilateral "C" osteotomies of the rami with rib or iliac crest bone grafts, which would carry the mandible forward and upward, closing the anterior open bite. The procedure would be completed with a suprahyoid myotomy, an intraoral splint maintaining the posterior segments out of occlusion and postoperative orthopedic stabilization with a Pitkin collar.

The third suggested a mandibular alveolar osteotomy from third molar to third molar (a modification of the Köle procedure) augmented by iliac crest grafts anteriorly and bilaterally to establish better mandibular morphology. This procedure will be discussed in more detail later in this paper.

One patient . . . one biologic entity with deviations from normal . . . three "differential diagnoses."

No one will argue with Theberge's principle of focusing correction on the point of greatest abnormality when it is applied carefully and with common sense. For example, in true mandibular prognathism with skeletal and dental Class III relationships we would certainly choose to set the abnormal mandible back to the relatively normal midface, rather than moving the maxilla forward to the prognathic mandibular position. It appears, however, that this principle loses some of its validity, if a truly scientifically determined "differential diagnosis" of the greatest anatomical abnormality cannot be made.

In the treatment of dentofacial abnormalities involving Class II and open bite, most authors today are advocating surgical correction through sagittal split advancement of the mandible, inverted L or C osteotomies and advancement of the mandible, or maxillary ostectomies combined with genioplastic procedures to correct the functional and esthetic problems associated with this deformity. Many of these authors are advocating the use of interocclusal splints to permit an amount of posterior bite opening *estimated* to be adequate to accommodate the expected postoperative decrease in facial height and to permit overcorrection anteriorly a distance *estimated* to be adequate to accommodate the postoperative retraction due to muscular adaptation. Some are recommending the use of postoperative stabilization with the Pitkin collar or modified Milwaukee brace type of orthopedic appliance.

Many of these same authors are recommending the concomitant use of suprahyoid myotomy to negate the relapse potential inherent in the stretching of that muscle group.

Spencer[10] did show some decrease in relapse potential following mandibular advancement procedures through the use of interocclusal splints and Pitkin collar. However, the decrease in relapse potential was not statistically significant and to some degree relapse still occurred.

Yellich and McNamara[11] in an experimental study of muscle lengthening with and without detachment and reattachment provided evidence to warrant the following observations. If a muscle is lengthened by skeletal alteration, it is better to detach that muscle. If the muscle is to be surgically detached, it is better to surgically reattach that muscle and, most importantly, if an option exists about lengthening a muscle during skeletal alteration, stability will be dramatically increased by *not* lengthening the muscle.

Therefore, if a high degree of relapse potential exists in cases where the mandible is advanced through surgical procedures which alter muscle relationships, and if the use of interocclusal splints and overcorrective procedures, *estimated* in their accuracy and *unpredictable* at best, reduce some relapse potential but do not eliminate it, and if the Pitkin collar or another orthopedic device slightly reduces relapse potential, but not significantly, why not utilize a procedure that, by its very nature and design, eliminates changes in muscle length and direction, thus eliminating the reported major cause of relapse in these cases.

It appears that a modification of the Köle alveolar osteotomy (Fig. 2) with concomitant bone grafting offers that possibility. The bone grafts help to stabilize the osteotomy procedure, as well as influence morphological changes in the face.

It is obvious that in many cases the Köle procedure does not adhere to Theberge's concept of directing the focus of correction at the source of the

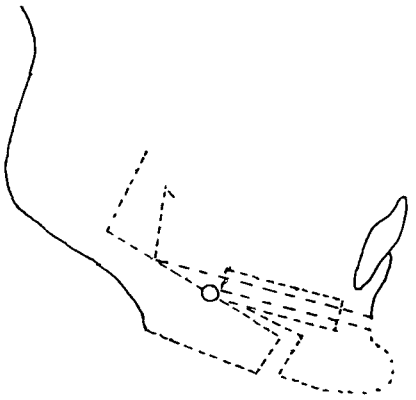


Fig. 2

problem or the greatest deviation from normal anatomy. Considering, however, our apparent inability to scientifically arrive at a differential diagnosis of the source of the problem, maybe we should abandon that philosophy where common sense, observation, experience, and supportive data overrule.

The modified Köle procedure or mobilization of the entire alveolar process had apparently not been published in the literature prior to 1974 when MacIntosh[12] described it as presenting encouraging possibilities, especially in cases of infantile apertognathia, i.e., openbite from the molars forward that develops early in childhood. He felt that diminished ramal height, as well as masticatory and suprahyoid-muscle relationships, mitigates against conventional ramus osteotomies in those cases, while anterior alveolar osteotomies do nothing to improve the molar occlusion. He also believed that maxillary ostectomies had significant relapse potential in these cases based on his and others' experiences throughout Europe.

Surgical Technique: Modified Köle Procedure

Mobilization of the entire mandibular alveolar process can be accomplished intraorally in most patients. In cases of micrognathia, particularly when complicated by limited mouth opening, the vertical osteotomy in the third molar area is best made from an extraoral approach (Fig. 2). Support of the mobilized alveolar segment with an iliac-crest graft and/or repositioned mental-process segment is usually indicated.

The surgical technique is similar to the more common alveolar procedures. A horizontal subapical osteotomy is completed through the lateral cortex of the mandible into medullary bone at a point 4-5 mm below the apices of the teeth. This osteotomy runs from one third molar area to the other. The lingual mucoperiosteum is left intact. Vertical osteotomies are then made from the crest of the alveolar ridge in the third molar areas, directed inferiorly to join the posterior limits of the horizontal osteotomy. The alveolar segment, thus outlined, is lifted free of the body of the mandible and supported in its preoperatively determined relationship to the maxilla with homologous iliac-crest grafts and/or the resected chin segment. These are introduced into the interspace between the alveolar segment itself and the basal bone of the mandible. The alveolar segment is stabilized to the basal bone of the mandible with intraosseous wires passed either laterally to or through the graft segments. Intermaxillary fixation in combination with circumzygomatic and/or anterior nasal spine suspension to the body of the mandible is affixed for stabilization. A reduction of the alveolar block on its lower surface in the molar area or of the subjacent bone of the mandibular body in the same area is sometimes necessary to maintain the preoperative vertical relationship of the body of the mandible to the maxilla.

Before this procedure should be added to the armamentarium of the orthodontist-surgeon team, certain questions must be answered. Does this pro-

cedure permit the achievement of morphological and esthetic objectives? Does this procedure permit the achievement of occlusal and functional objectives? Does this procedure provide an acceptable degree of stability of skeletal and dental relationships?

The following case reports will be presented in an attempt to answer these questions.

G.W. (Fig. 3)

This patient, an 18 year old male Caucasian, had a skeletal Class II open-bite relationship and a Class II, Division 1, open-bite dental malocclusion. The treatment plan involved palatal suture expansion followed by orthodontic preparation with fixed appliances prior to the surgical correction of the skeletal and dental malocclusion.

No teeth were extracted. The teeth were uprighted as much as possible over basal bone through proper torque control. The arches were coordinated in size and form to permit maximum skeletal and dental correction at the time of surgery.

The modified Köle procedure or total mandibular alveolar osteotomy was performed and the orthodontic appliances used as part of the intermaxillary fixation mechanism. Fixation was for 6 weeks.

Postsurgical cephalometric evaluation at the time of fixation indicated the mandibular dentition was advanced 4.5 mm as measured by the ANB difference along the occlusal plane. The ANB angle was decreased from 5° to 2°. Evaluation of the posttreatment cephalometric films at the time of appliance removal and six months later indicated no regression of the surgical correction either during the fixation period or after treatment. All cephalometric measurements remained essentially the same.

Superimposition of pretreatment and follow-up posttreatment tracings (Fig. 4) corroborates this stable correction and also indicates relative stability of the anterior and posterior facial heights. Method of superimposition is on SN registered at S.

The facial and dental relationships have remained stable throughout the posttreatment period (Fig. 4).

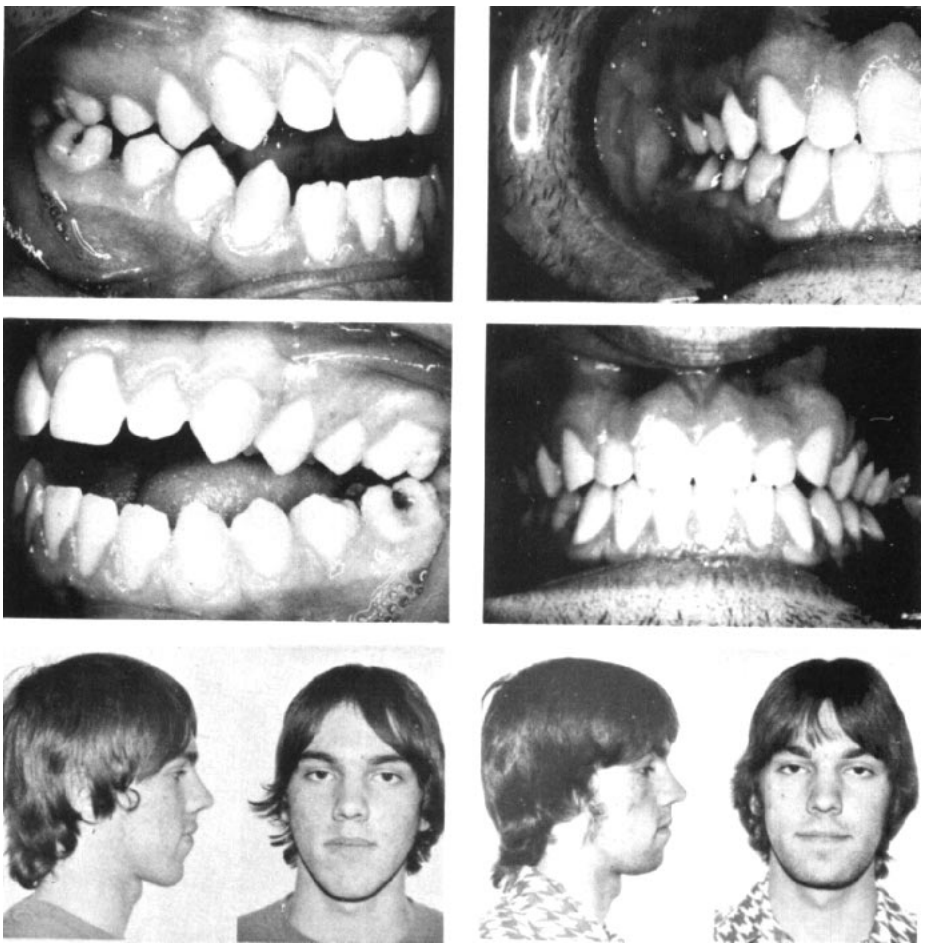
Careful observation of the symphyseal region reveals, however, a slight resorption and remodeling of the contour in the area of the autogenous graft placement. This resorption is in response to the pressures placed on the bony anatomy by the actively functioning musculature of the lower lip and mentalis muscle.

J.C. (Fig. 5)

A 26 year old male Caucasian displayed a skeletal Class II and a skeletal open-bite relationship and a dental Class II, Division 1, open-bite malocclusion. The treatment plan involved palatal suture expansion. The midpalatine suture, because of the patient's age, was surgically opened, the expansion appliance placed and activated immediately following the surgery. The expansion was followed by orthodontic presurgical preparation with fixed appliances. No teeth were extracted. The teeth were uprighted over basal bone through proper torque control. The arches were coordinated in size and form to permit maximum skeletal and dental correction at the time of surgery.

The modified Köle procedure was performed and the orthodontic fixed appliances were used as part of the intermaxillary fixation mechanism. Fixation was for five weeks.

Postsurgical cephalometric evaluation during fixation showed the mandibular dentition was advanced 3.5 mm as measured by the ANB difference along the occlusal plane. The ANB angle was reduced from 5° to 1°.



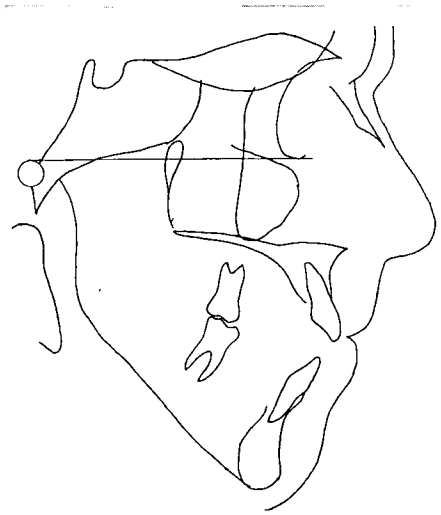


Fig. 3

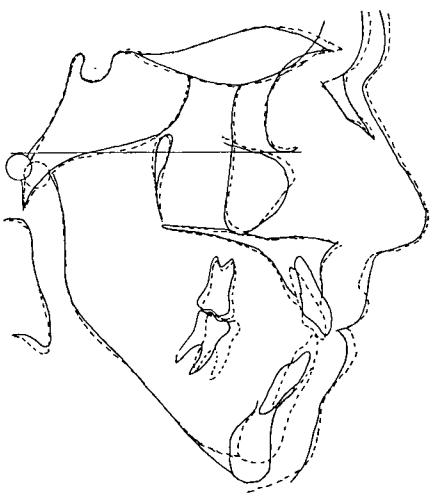


Fig. 4

Appliances were removed one week after the discontinuation of intermaxillary fixation at the patient's request. Since the postsurgical occlusion was deemed acceptable and the skeletal correction had remained stable during that period, there was only slight concern regarding this early appliance removal.

Evaluation of the posttreatment cephalogram at the end of treatment and two years later indicated no regression of the surgical correction, as the ANB angle and difference measured at the occlusal plane have remained relatively stable.

Figure 6 shows the case two years after treatment and the superimposition (SN) of pretreatment and follow-up posttreatment tracings. The facial morphology and dental occlusion have remained stable.

Not surprisingly, the symphyseal region which was advanced significantly in this case because of the severity of the Class II open bite has shown a rather large degree of remodeling and resorption. Soft tissue contours have remained acceptable.

This approach to the correction of the Class II open-bite problem is not proposed as a panacea, nor is it without its inherent problems. The surgical technique must be done carefully to avoid possible root amputation and devitalization of the dentition. There is routinely a transient parasthesia in the lower lip and overlying soft tissues of the lower face because of the surgical irritation of the sensory nerve supply to the area. In the sixteen cases in which we have used this procedure, parasthesia has lasted from 3 months to 18 months with no instance of permanence.

As has been demonstrated in these two cases, there is a tendency for resorption of the symphyseal region and the incorporated bone graft during the posttreatment period. This resorption, if extensive enough, can necessitate a second surgical procedure. In two of the sixteen cases in which we have used this approach, the bone graft resorbing in the area in which it anteriorly supports the mandibular alveolar process has necessitated a second surgical procedure, an alveolar osteotomy from mandibular canine to canine to close a slight open bite and to augment further the symphyseal region. In two additional cases a secondary augmentation genioplasty had to be performed for esthetic purposes only.

In spite of these difficulties it is an effective approach to the Class II open-bite problem, even in cases in which the deviation from normal was extreme. *J.T.*

This patient whose pretreatment records are shown in Figure 1 had an extreme skeletal Class II open-bite relationship and an extremely severe Class II, Division 1, open-bite malocclusion. Gross collapse of the maxillary arch and arch-length insufficiency necessitated palatal expansion procedures followed by the extraction of four first premolars. Prior to surgical correction of the mandibular retrognathia and open bite, the arches were coordinated in size and form and the teeth uprighted over basal bone through the use of comprehensive orthodontic appliances. A preliminary surgical procedure (maxillary anterior alveolar osteotomy) was completed to intrude the elongated premaxillary segment and the six maxillary anterior teeth.

The Köle total alveolar osteotomy was performed as a second separate surgical procedure along with bilateral iliac-crest onlay grafts.

Postsurgical cephalometric evaluation at the time of fixation indicated the mandible was advanced 11 mm as measured by the ANB difference along the occlusal plane (part of this reduction was achieved with the earlier an-

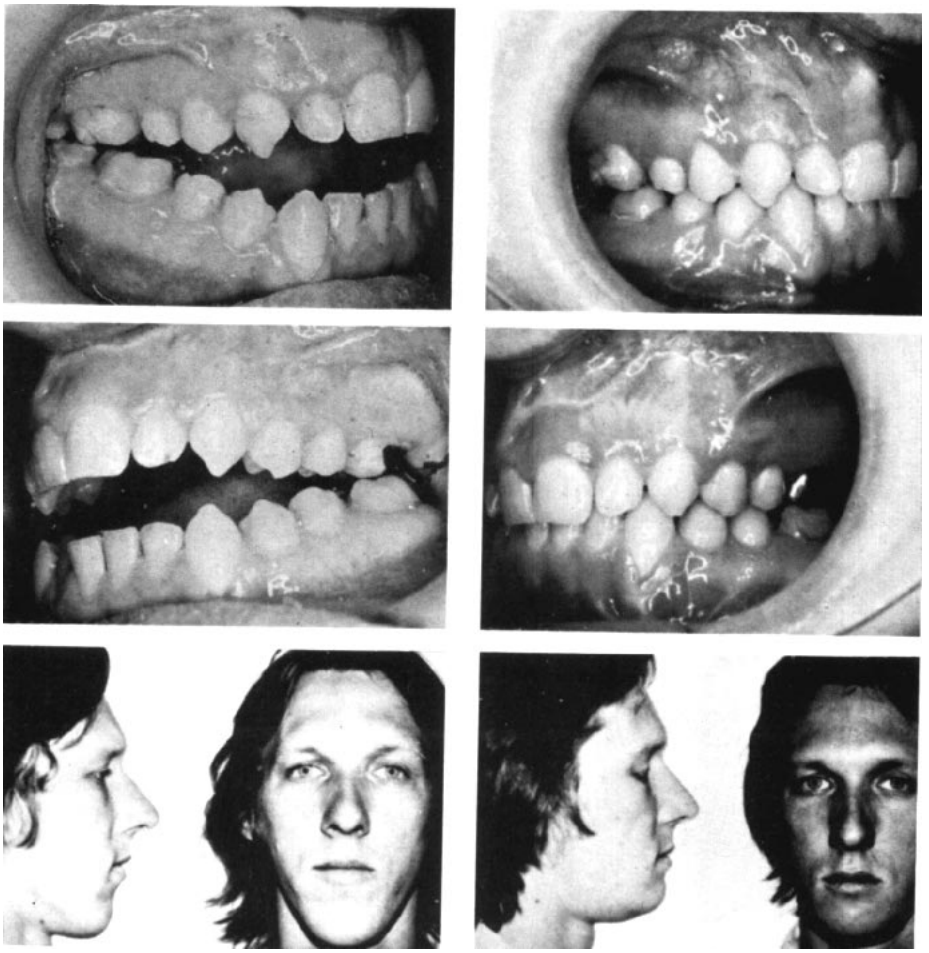


Fig. 5

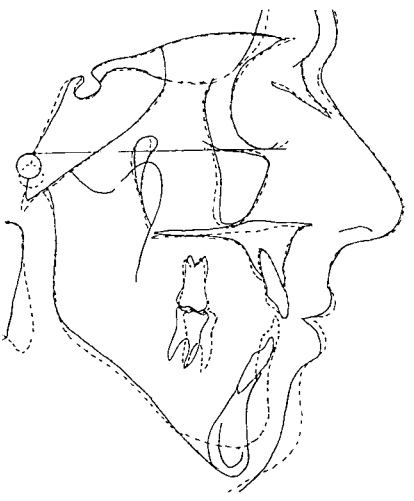
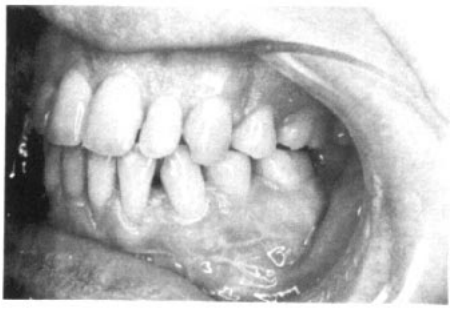


Fig. 6



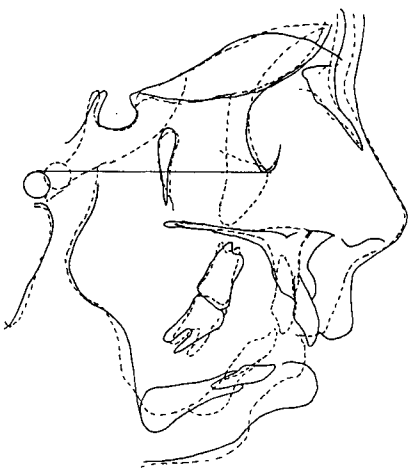


Fig. 7

terior maxillary osteotomy) and the ANB angle reduced from 14.5° to 8°.

Because of the expected partial resorption of the onlay grafts, a silastic implant was placed prior to the removal of orthodontic appliances. This procedure further reduced the cephalometrically determined ANB difference along the occlusal plane an additional 6 mm and reduced the ANB angle from 8° to 5°. Skeletal and dental relationships remained relatively stable throughout the two year posttreatment observation period with the exception of the expected remodeling resorption in the symphyseal region.

Superimposition on SN registered at S of pretreatment and follow-up posttreatment tracings (Fig. 7) corroborates the stability of the anteroposterior correction and the relative stability of the anterior and posterior facial heights. Facial morphology has remained acceptable in spite of the alterations occurring concomitant with the symphyseal remodeling. Throughout the posttreatment period the dental relationships (Fig. 7) have remained stable.

The final verdict is not in yet regarding the ultimate solution to the problem of relapse in the treatment of the Class II open-bite problem. The approach presented in this paper, in spite of its lack of perfection, offers a possibility for avoiding much of the relapse which has plagued orthodontists and surgeons alike in the management of this difficult problem.

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