chapter 4

Basic Guidelines for the Diagnosis and Treatment of Specific Dentofacial Deformities

This chapter uses case studies to demonstrate individual dentofacial problems, combinations of problems, and the nuances involved in treating these patients to achieve optimal results. Patients with similar skeletal, soft tissue, and occlusal characteristics are grouped for convenience in description. Clinicians should remember, however, that each patient has a unique set of dentofacial problems requiring a specific treatment response, and a patient may have more than one deformity.

The following basic deformities and treatment principles for each deformity are discussed: *(1)* mandibular anteroposterior deficiency, *(2)* mandibular anteroposterior excess, *(3)* maxillary anteroposterior deficiency, *(4)* maxillary anteroposterior excess, *(5)* maxillary vertical deficiency, *(6)* maxillary vertical excess, *(7)* cases requiring rotation of the maxillomandibular complex, *(8)* open bite deformities, and *(9)* dentofacial asymmetry.

Mandibular Anteroposterior Deficiency

Patients with mandibular anteroposterior deficiency are without a doubt the largest single group of surgical orthodontic patients.

Class II, division 1 malocclusion

Clinical characteristics

Profile view

- A retruded, weak chin
- A deficient mandible giving the illusion of a large nose
- A short chin-to-throat length
- An obtuse lower lip–chin–throat angle

- An everted lower lip that wedges in behind the incisors
- Often, an upper lip that appears short, curled, and protrusive
- An acute labiomental fold
- An increased facial contour angle (convex profile)

Frontal view

- A curled lower lip
- A weak chin with the appearance of a double chin
- A deep labiomental fold

Dental characteristics

- A large overjet
- Usually, an increased overbite and an accentuated curve of Spee
- Usually, crowding in the mandibular incisor area
- A tendency for maxillary incisor spacing

Treatment

Growth modification is not feasible after adolescence. Without surgical correction of the jaw relationship, an orthodontic compromise will consist of the following:

1. Correction of excessive overjet
   a. Retraction of maxillary incisors (with or without extraction of first premolars)
   b. Proclination of mandibular incisors
2. Correction of excessive overbite
   a. Intrusion of maxillary incisors
   b. Intrusion of mandibular incisors
   c. Downward rotation of the mandible by opening the bite

At the beginning of treatment, the clinician must decide whether the treatment approach will be solely orthodontic or orthodontic and surgical. Because the orthodontic treatments in the two approaches differ substantially, it does not make sense to tell patients who are beginning orthodontic treatment, "Let's see how the treatment progresses; we may get away without surgery."

Presurgical orthodontics

The basic presurgical orthodontic goals for patients with Class II, division 1 malocclusion are as follows:

1. Align both dental arches.
2. Place incisors in their planned anteroposterior and vertical plane positions. It is extremely important to position the incisors correctly. Incisor position dictates surgical movement, and surgical movement in turn dictates esthetic results.
3. Establish arch compatibility.

Note particularly the orthodontic goal of properly positioning the maxillary and mandibular incisors presurgically in both anteroposterior and vertical planes of space. The position of the incisors dictates the surgical movement, and failure to eliminate dental compensation limits surgical correction. Because of crowding in the incisor area and a severe curve of Spee, it is often necessary to extract two first premolars in the mandibular arch. Extractions in the maxilla, however, frequently are not indicated. If there is some crowding in the maxillary arch, it is often possible to avoid extraction by gaining additional space through expansion of the maxillary arch—an adjustment often needed to accommodate the mandibular arch after surgical advancement. If extraction in the maxilla is deemed necessary, it may be advantageous to extract second premolars to enable minimal retraction of incisors. Retraction of these incisors otherwise would not only limit surgical movement but also have adverse esthetic effects (loss of lip support and increased nasolabial angle).

Patients with a Class II, division 1 malocclusion often have an excessive curve of Spee. It is important not to level the curve routinely before surgery. Patients with short faces often have prominent chins and, from an esthetic point of view, do not tolerate mandibular advancement. In these cases it is preferable not to level the curve of Spee presurgically. Surgical advancement of the mandible will result in a rotational movement, advancing the mandibular incisors with only slight advancement of the chin (see chapter 3). As a general rule, it is better to level

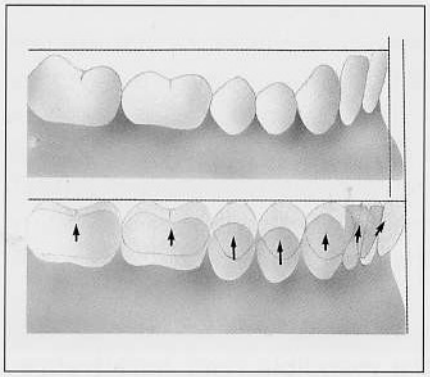


Fig 4-1 Orthodontic leveling of the curve of Spee will increase the anteroposterior arch length. If crowding is present in the incisor area, additional anteroposterior space will be required for arch alignment. Every 1 mm of curve leveling will result in a 0.6- to 1.0-mm increase in arch length.

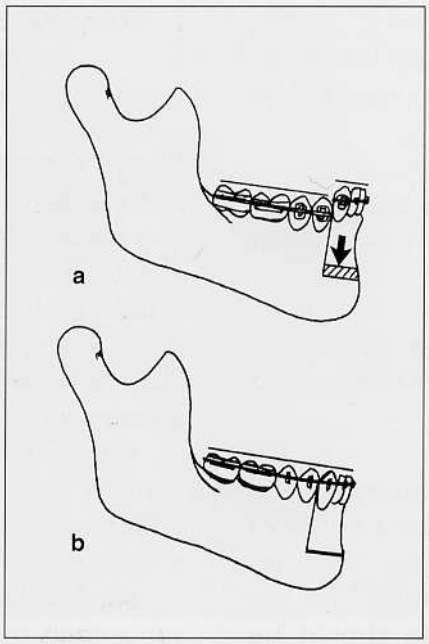


Fig 4-2 The curve of Spee can be leveled surgically by segmental orthodontic alignment of the dental arch *(a)*, followed by surgical inferior repositioning of the anterior dentoalveolar segment *(b)*.

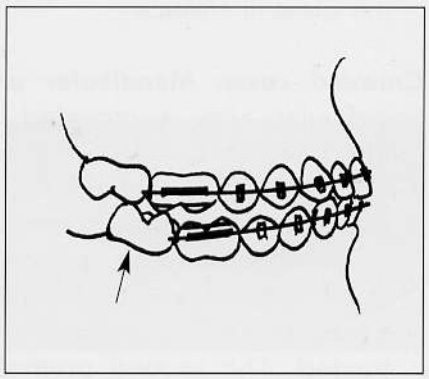


Fig 4-3 Leveling of the mandibular arch should include the second molars. An unbanded molar *(arrow)* often interferes with establishing the planned occlusion at surgery.

the curve by extrusion of premolars after surgery in short faces. The greater the facial height, the greater the likelihood that leveling should be done presurgically by intrusion of the incisors. Because anteroposterior space is needed for leveling and alignment, extractions are more likely to be necessary when a severe curve of Spee is combined with mandibular incisor crowding (Fig 4-1). Surgical leveling of the curve may be considered (Fig 4-2).

Arch compatibility plays an important role in immediate postsurgical stability and gives the surgeon an exact idea of where to position the mandible when a splint is not used during surgery. Three important aspects of arch compatibility follow:

1. Intercanine width is important. If the maxillary intercanine width is insufficient, it will not be possible to advance the mandible into the planned occlusion and anteroposterior position. Because a premature contact may shift the mandible laterally, a rotated canine may make it impossible to correct dental midlines. The use of an acrylic splint at surgery to eliminate this problem does not make sense, since the correct intercanine width must be achieved eventually. If it is achieved before surgery, the surgery will be more accurate, and tooth interdigitation will improve.
2. The mandibular second molars should be banded and leveled with the first molars. An overerupted, elevated, often rotated, unbanded second molar often causes occlusal interference at surgery (Fig 4-3).
3. Similar maxillary and mandibular arch forms should be established to prevent possible postsurgical crossbites. In mandibular deficiency cases, the maxillary arch is often slightly narrow and will need expansion to accommodate the mandibular arch after advancement.

Orthodontic mechanics

Crowded cases: Maxillary arch When the maxillary arch is crowded, the following approach is recommended:

1. Second premolars should be extracted.
2. Headgear use may be necessary to support the Class III elastics.

Crowded cases: Mandibular arch When the mandibular arch is crowded, the following methods should be used:

1. Extraction of premolars may be required. In cases with crowding, accentuated curve of Spee, and the need for mandibular incisor retraction, the first premolars should be extracted. The second premolars should be extracted in cases requiring less anteroposterior space for the planned mandibular incisor positioning.
2. Sectional arch retraction of the mandibular canines is recommended, because the anchorage characteristics are excellent.
3. Class III mechanics (eg, Class III elastics) may be needed, depending on the severity of the mandibular canine position problem, the mandibular incisor position, crowding, and the curve of Spee.

Noncrowded cases When minimal crowding or mild spacing between the teeth is present, a nonextraction approach is recommended:

1. During the leveling process in these cases, the use of Class III mechanics is mandatory.
2. As much retraction or uprighting of the mandibular incisor as possible is achieved with the aid of Class III mechanics (eg, J-hooks or Class III elastics and maxillary headgear support).
3. In these cases, maxillary and mandibular arches are coordinated to fit. When the overjet is not too great (4 to 5 mm), the patient is asked to move the mandible forward so the coordination of the maxillary and mandibular arches can be checked. The best way of checking coordination, however, is to take rough study casts and hand-simulate the surgical advancement of the mandible. Be sure to coordinate the overjet with the orthodontic prediction tracing.

Surgical treatment: Advancement of the mandible

The surgical technique of choice is the bilateral sagittal split ramus osteotomy advancing the distal (tooth-bearing) segment to maximum dental intercuspation. The position of the maxillary and mandibular incisors controls the amount the mandible can be advanced, as well as the facial height after surgery. Correct condyle positioning during surgery is extremely important (see the discussion of condylar sag in chapter 5).

The chin may still appear deficient after advancement of the mandible, and an advancement genioplasty may be indicated to improve final esthetics. The clinician makes this decision according to the presurgical visual treatment objective.

Light (2.5- to 3.5-oz) Class II elastics are placed after the completion of surgery. These elastics will override proprioception, guide the "new" occlusion, and bring the teeth into a solid occlusion.

Postsurgical orthodontics

The goals of postsurgical orthodontics are to bring the teeth into final occlusion and maintain them in that position. Treatment usually consists of final leveling of the curve of Spee, correction of minor crossbites, and final closure of small extraction spaces.

Case A.B.

A.B., a 16-year-old female patient, was referred to the orthodontist for the orthodontic treatment of a Class II malocclusion.

Main complaint

The patient mainly wanted her increased overjet corrected and also felt that her chin appeared too small.

Medical history

Her medical history was noncontributory.

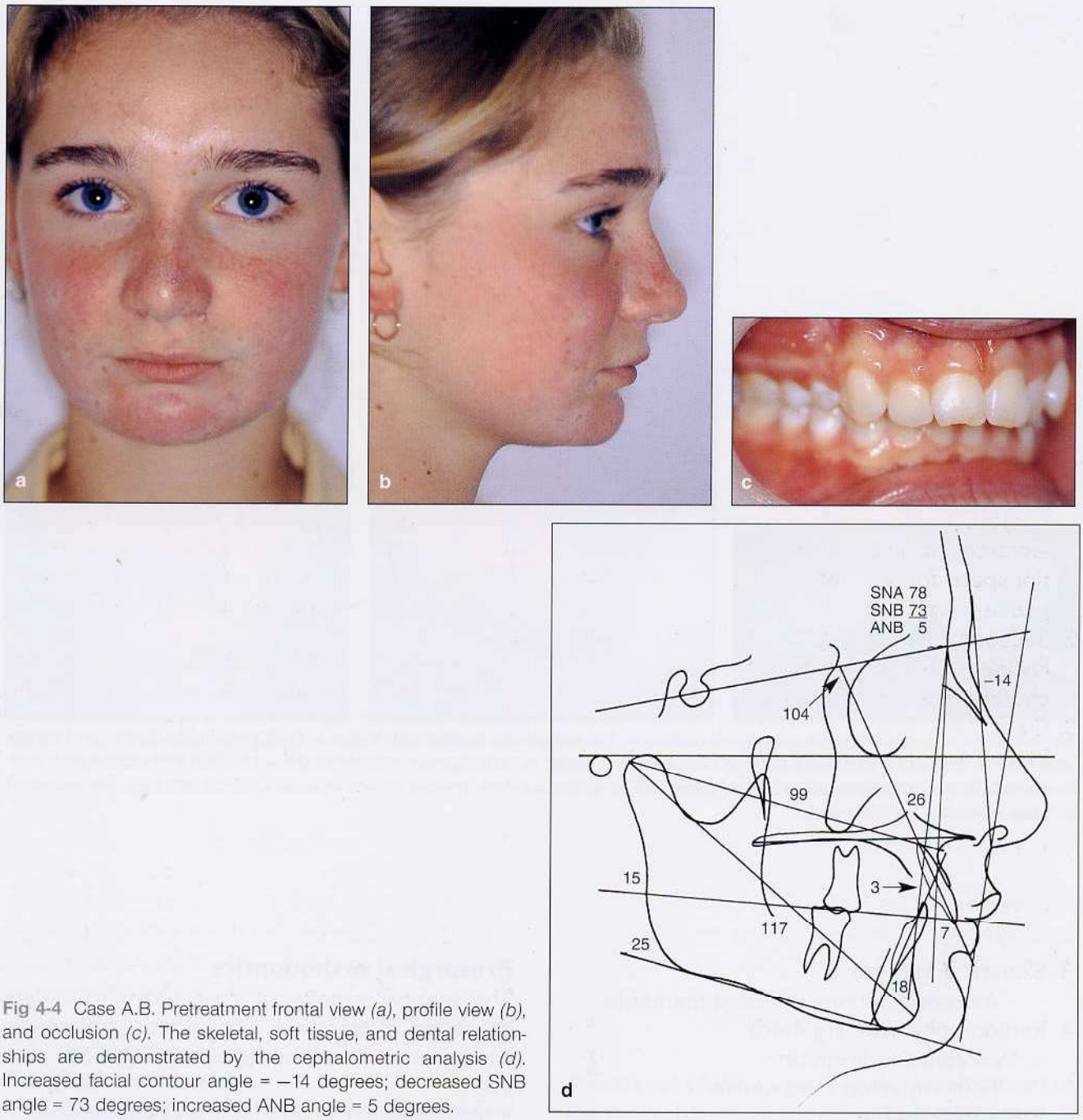


Fig 4-4 Case A.B. Pretreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*. The skeletal, soft tissue, and dental relationships are demonstrated by the cephalometric analysis *(d)*. Increased facial contour angle = −14 degrees; decreased SNB angle = 73 degrees; increased ANB angle = 5 degrees.

Clinical examination

1. Soft tissue
   a. Frontal view (Fig 4-4a)
      - Short, deficient chin
      - Everted lower lip
      - Short lower facial third
   b. Profile view (Fig 4-4b)
      - Convex profile
      - Deep labiomental fold
      - Deficient mandible
2. Dental (Fig 4-4c)
   - Class II, division 1 malocclusion
   - Slightly accentuated curve of Spee
   - Slightly narrowed maxillary arch

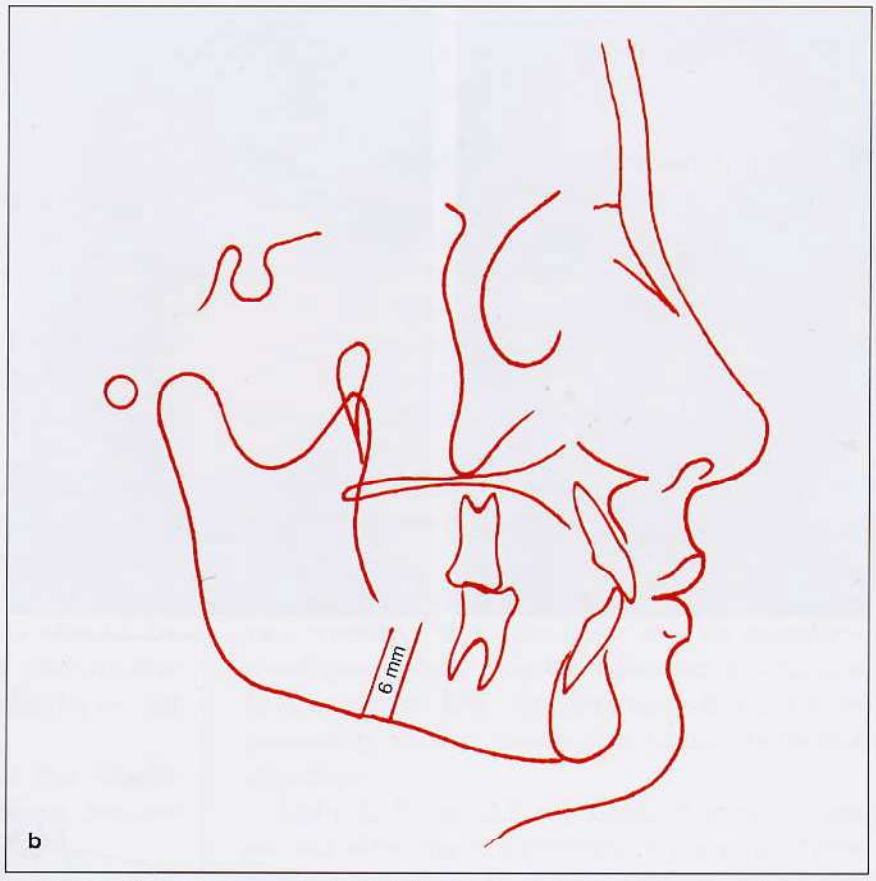


Fig 4-5 Case A.B. *(a)* Immediate presurgical occlusion. The patient was treated with lingual orthodontics in the maxilla, and buccal attachments (lingual buttons) were bonded presurgically to assist in intraoperative maxillomandibular fixation and postsurgical elastic control. *(b)* Surgical visual treatment objective indicating that a 6-mm mandibular advancement will be required. The expected soft tissue result is demonstrated.

3. Skeletal (Fig 4-4d)
   - Anteroposteriorly deficient mandible
4. Radiographic (see Fig 4-4d)
   a. Panoramic radiograph
      - Four impacted third molars
   b. Cephalometric
      - Class II, division 1 dental relationship
      - Slight maxillary dental protrusion
      - Mandibular anteroposterior deficiency

Problem list

1. Class II malocclusion
2. Mandibular anteroposterior deficiency
3. Deep bite
4. Slightly accentuated curve of Spee
5. Narrow maxillary arch
6. Slight protrusion of maxillary incisors

Presurgical orthodontics

The surgical removal of impacted third molars preceded presurgical orthodontic treatment, which consisted of the following (Fig 4-5):

- Maxillary arch: use of lingual orthodontics
  - Slight expansion of the maxillary arch to accommodate the mandibular arch after advancement
  - Slight retraction of maxillary incisors
- Mandibular arch: leveling of the curve of Spee
  - Establishment of a good arch form
  - Use of buccal orthodontics in the mandibular arch

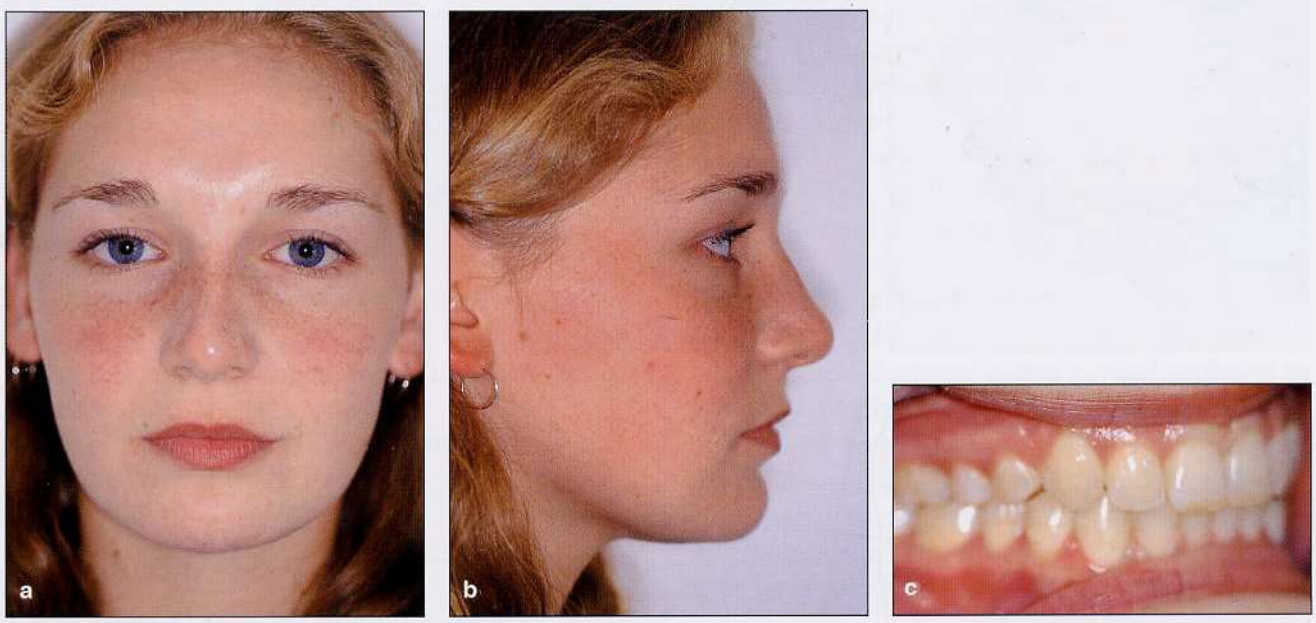


Fig 4-6 Case A.B. Posttreatment results are demonstrated in frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

Surgical treatment

The surgical treatment in this case consisted of a bilateral sagittal split ramus osteotomy to advance the mandible.

Postsurgical orthodontics

The surgery was performed after a 10-month period of orthodontic preparation. The postsurgical orthodontic treatment, which lasted 4 months, involved finalization of the occlusion. After band removal, the patient was placed in retention. Figure 4-6 illustrates the treatment result 8 months after orthodontic band removal.

Because of the general underdevelopment of the mandible, microgenia, or chin deficiency, is often found in combination with mandibular anteroposterior deficiency. In these cases, correction requires an augmentation sliding genioplasty in addition to mandibular advancement. Augmentation genioplasty, however, is not a substitute for mandibular surgery. Case O.J. illustrates the improved esthetic result after both mandibular advancement and augmentation genioplasty (Fig 4-7).

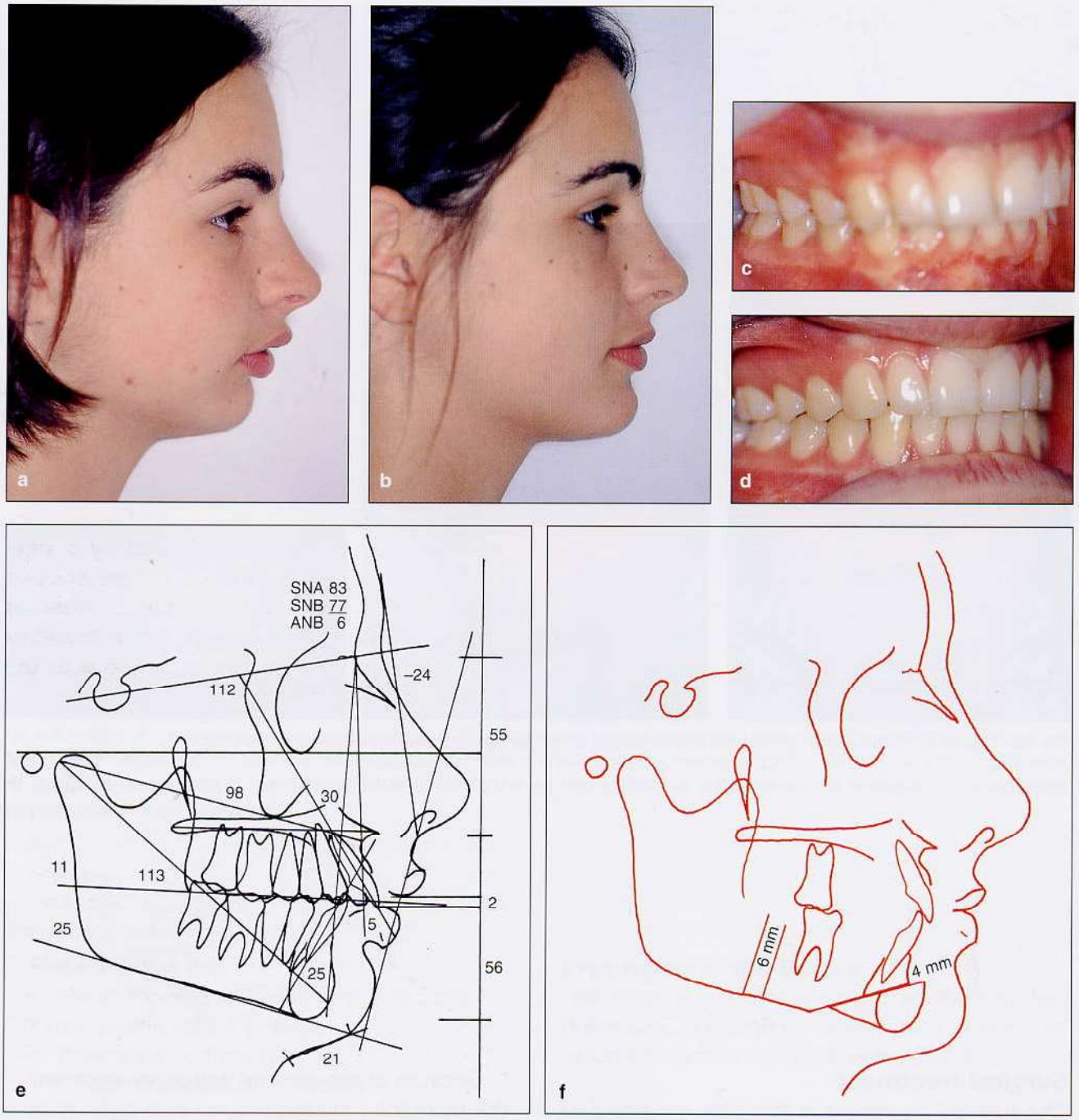


Fig 4-7 Case O.J. Preoperative profile view *(a)*, postoperative profile view *(b)*, preoperative occlusion *(c)*, and postoperative occlusion *(d)*. The cephalometric analysis *(e)* and surgical prediction tracing *(f)* demonstrate the esthetic enhancement from a 6-mm mandibular advancement combined with a 4-mm advancement of the chin.

Class II, division 2 malocclusion

Clinical characteristics

Profile view

- The "chin button" is pronounced.
- A deep labiomental fold is often present.
- The lower lip appears anteroposteriorly deficient and is curled.
- The lower facial height is short, and the mandible appears square.
- The mandibular plane angle tends to be low.

Frontal view

- The face appears short because of decreased vertical height.
- There is a curled lower lip and a deep labiomental fold.
- The elevator muscles of the mandible are usually well developed.

Dental characteristics

- Retroclined maxillary central incisors
- Labially flared maxillary lateral incisors
- A deep overbite, which is both skeletal and dental in origin
- Excessive curve of Spee
- Gingival tissue irritation behind the maxillary incisors and sometimes also on the labial aspect of the mandibular incisors due to deep bite
- A tendency toward clicking of the temporomandibular joints, probably related to the anterior locking effect of the deep bite

Treatment

Presurgical orthodontics

The basic presurgical orthodontic principles apply in Class II, division 2 malocclusion—namely, the need to properly position the maxillary and mandibular incisors (vertically, as well as in the anteroposterior plane), the need to level the curve of Spee, and the need to coordinate the dental arches. It is especially important to tip the maxillary incisors labially to create a good arch form, lip support, and a sufficient overjet. In severe deep bite cases it may be difficult to level the curve of Spee in the mandibular arch, and it may be necessary to open the bite with a glass ionomer bite plane cemented to the molars. Surgical leveling by segmental surgery may be considered, in which case segmental orthodontic alignment will be necessary (Fig 4-8).

In patients with a Class II deep bite occlusion, postsurgical leveling of the curve of Spee is indicated. Advancement of the mandible before total leveling of the curve will increase the facial height, and because of the rotation of the occlusal plane, the chin will not advance as much as the incisors (Fig 4-9).

Orthodontic mechanics

Maxillary arch The maxillary incisors can be leveled and advanced with a curved archwire or a simple flexible archwire followed by a steel round wire with a pronounced inverse occlusal curve. A stabilizing archwire should be fitted as soon as possible. The change in the maxillary incisor position should be reconciled with the arch length and lip support.

Mandibular arch In the mandibular arch, the teeth should be leveled with the aid of Class III elastics and soft flexible wires, but it is not necessary to completely correct the curve of Spee. This can be done after surgery, especially if there is a deep overbite and an increase in lower facial height is required. The stabilizing wire should have the curve of Spee bent into it. Presurgically, a deep curve is advantageous because the anterior part of the mandible is advanced downward and forward to create a Class I incisor relationship while the lower anterior facial height is increased (Fig 4-10).

Surgical treatment

A few surgical options for the correction of the occlusion and esthetic improvement may be considered:

1. Advancement of the mandible by means of a bilateral sagittal split ramus osteotomy.
2. Advancement of the mandible by means of a bilateral sagittal split ramus osteotomy combined with a reduction genioplasty to reduce

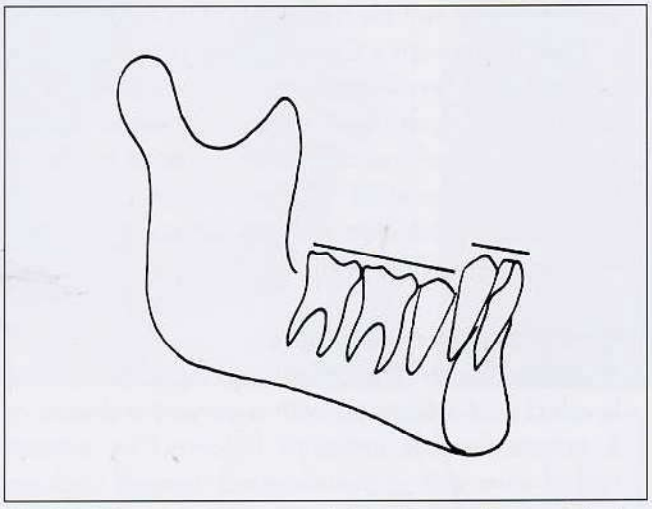


Fig 4-8 When a natural step exists in the mandibular arch, the dental arch may be leveled in segments, followed by surgical leveling. Surgical leveling has two advantages: no additional anteroposterior arch length is required and orthodontic treatment time is shortened.

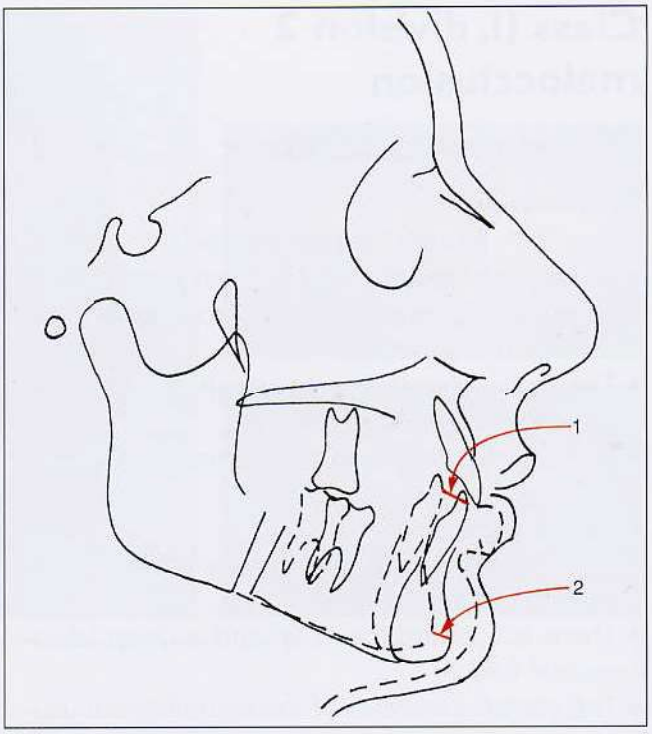


Fig 4-9 The incisor advancement (1) is greater than the advancement of pogonion (Pog) (2) because of the forward and downward rotation of the mandible.

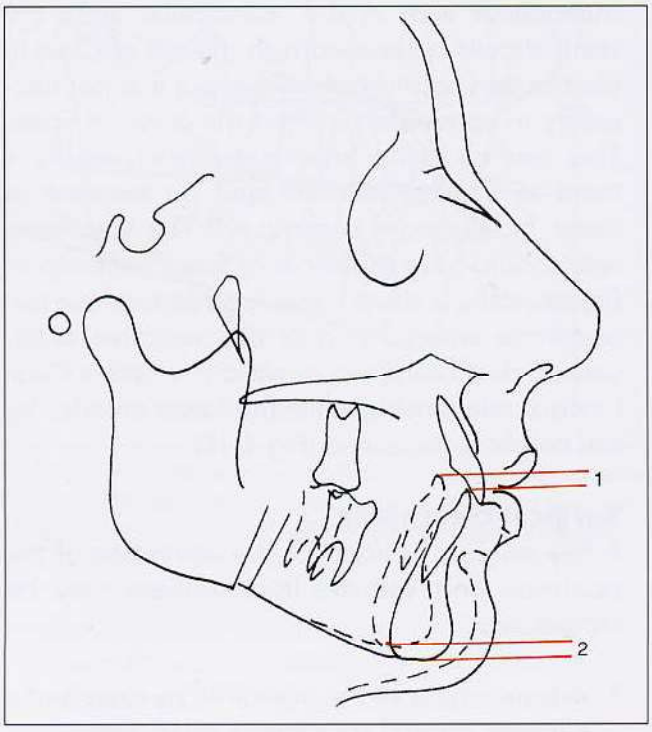


Fig 4-10 Downward rotation of the incisors during correction of the deep bite (1) will increase the anterior height of the mandible. Menton will be inferiorly repositioned (2).

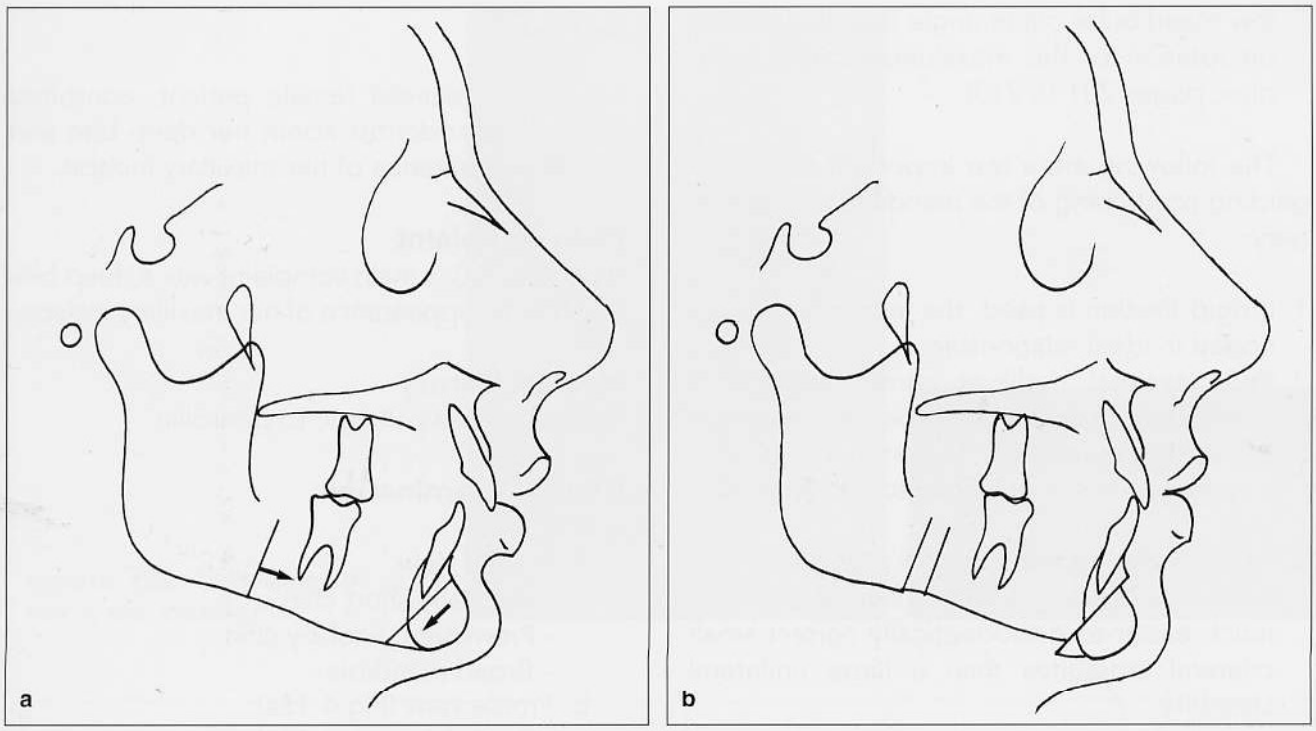


Fig 4-11 Bilateral sagittal split ramus osteotomy combined with a reduction genioplasty. By angling the osteotomy for reduction genioplasty *(a)*, the anterior height of the mandible is increased as the chin slides posteriorly and inferiorly *(b)*.

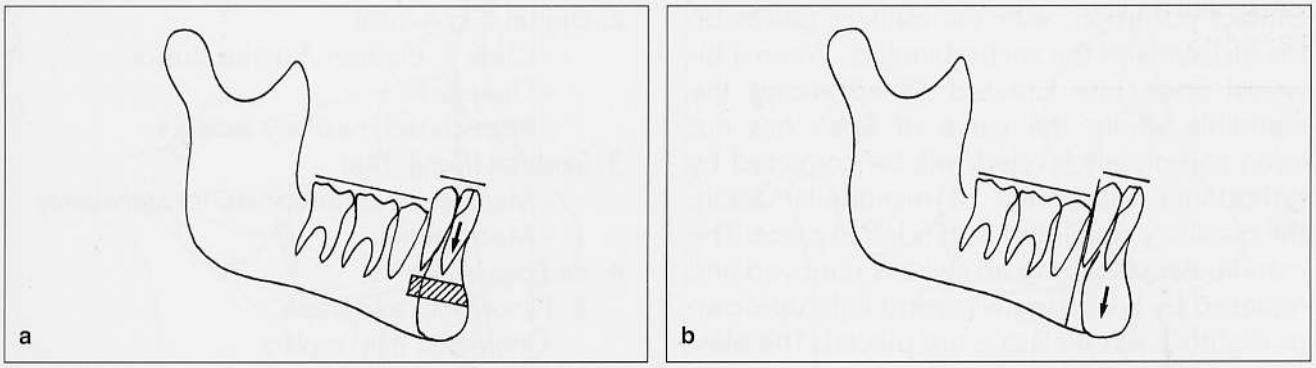


Fig 4-12 The curve of Spee may be surgically leveled after segmental orthodontic alignment by a subapical osteotomy *(a)* or an osteotomy including the lower border *(b)*, which will increase the vertical height of the face.

the chin prominence. By angling the osteotomy of the genioplasty, a vertical increase in the facial height can be achieved (posterior and inferior slide of the chin) (Fig 4-11).

3. A bilateral sagittal split osteotomy advancing the mandible combined with an anterior segmental osteotomy leveling the occlusal plane. The segmental osteotomy may be subapical or may include the body of the mandible, which will increase the vertical height of the face (Fig 4-12).
4. A total subapical osteotomy of the mandible advancing the dentoalveolar segment of the mandible. In this case, the chin position is maintained while the lower lip is advanced because of the dentoalveolar advancement.
5. Rotation of the maxillomandibular complex is a possible solution in cases with a severely

low mandibular plane angle (see the section on rotation of the maxillomandibular complex, pages 201 to 213).

The following are a few important points regarding positioning of the mandible during surgery:

1. If rigid fixation is used, the incisors are positioned in ideal relationship.
2. Keep skeletal midlines correct even if it means a slight dental discrepancy. The orthodontist can correct a mild dental midline discrepancy but not an incorrect skeletal midline.
3. There is often a tendency for posterior crossbites, so keep the crossbites symmetrical. It is much easier to orthodontically correct small bilateral crossbites than a large unilateral crossbite.

Postsurgical orthodontics

After surgery, patients often have a three-point contact occlusion, with the contact points on the incisors and the second molars. When a bilateral open bite (created by advancing the mandible where the curve of Spee has not been completely leveled) will be corrected by orthodontic movement of mandibular teeth, the maxillary stabilizing arch is left in place. The mandibular stabilizing archwire is removed and replaced by a working wire, and light up-down or slightly Class II elastics are placed. The elastics serve a dual purpose: *(1)* to bring the teeth into a solid occlusion and *(2)* to "override" the patient's proprioception, which will tend to place the mandible in maximum intercuspation.

Postoperative crossbites can be corrected by through-the-bite elastics. From this point forward, the patient's orthodontic treatment will be routine.

The retention phase of these patients is the same as for routine orthodontic cases. After 3 to 4 months, retainer use can be reduced to only nighttime. If the teeth are stable, retainer use may be discontinued after a few more months.

Case T.G.

T.G., a 16-year-old female patient, consulted with the orthodontist about her deep bite and the flat appearance of her maxillary incisors.

Main complaint

As noted, T.G.'s main complaint was a deep bite and the flat appearance of her maxillary incisors.

Medical history

The patient was allergic to penicillin.

Clinical examination

1. Soft tissue
   a. Frontal view
      - Vertically short chin
      - Prominent, knobby chin
      - Broad mandible
   b. Profile view (Fig 4-13a)
      - Deep labiomental fold
      - Prominent chin
      - Short lower-third facial height
2. Dental (Fig 4-13b)
      - Class II, division 2 malocclusion
      - Deep bite
      - Retroclined maxillary incisors
3. Skeletal (Fig 4-14a)
      - Mandibular anteroposterior deficiency
      - Macrogenia
4. Radiographic
   a. Panoramic radiograph
      - Impacted third molars
   b. Cephalometric (see Fig 4-14a)
      - Class II, division 2 malocclusion
      - Deep bite
      - Retroclined maxillary incisors
      - Mandibular anteroposterior deficiency
      - Macrogenia

Problem list

1. Class II occlusion
2. Mandibular anteroposterior deficiency
3. Deep bite
4. Retroclined maxillary incisors
5. Prominent chin

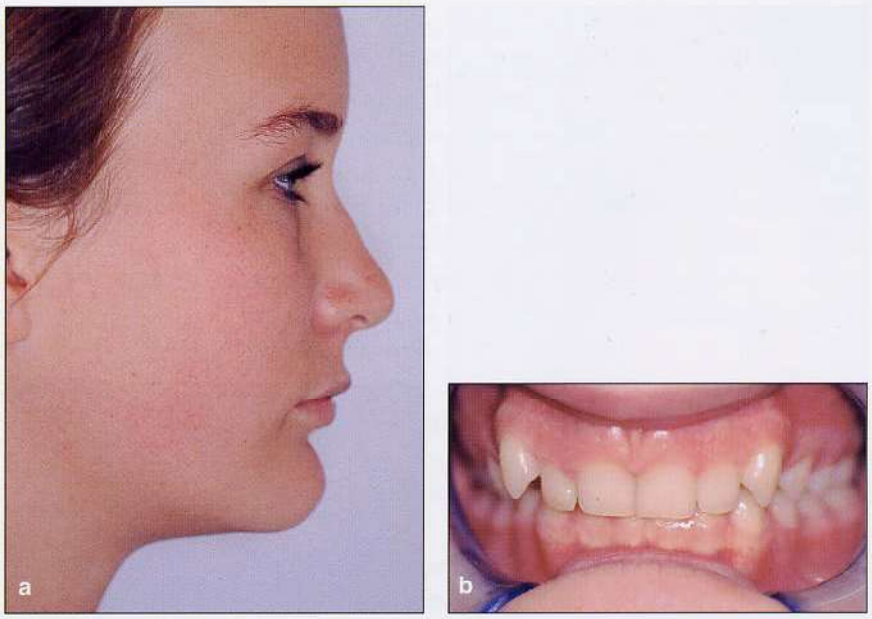


Fig 4-13 Case T.G. Pretreatment profile view *(a)* and occlusion *(b)*.

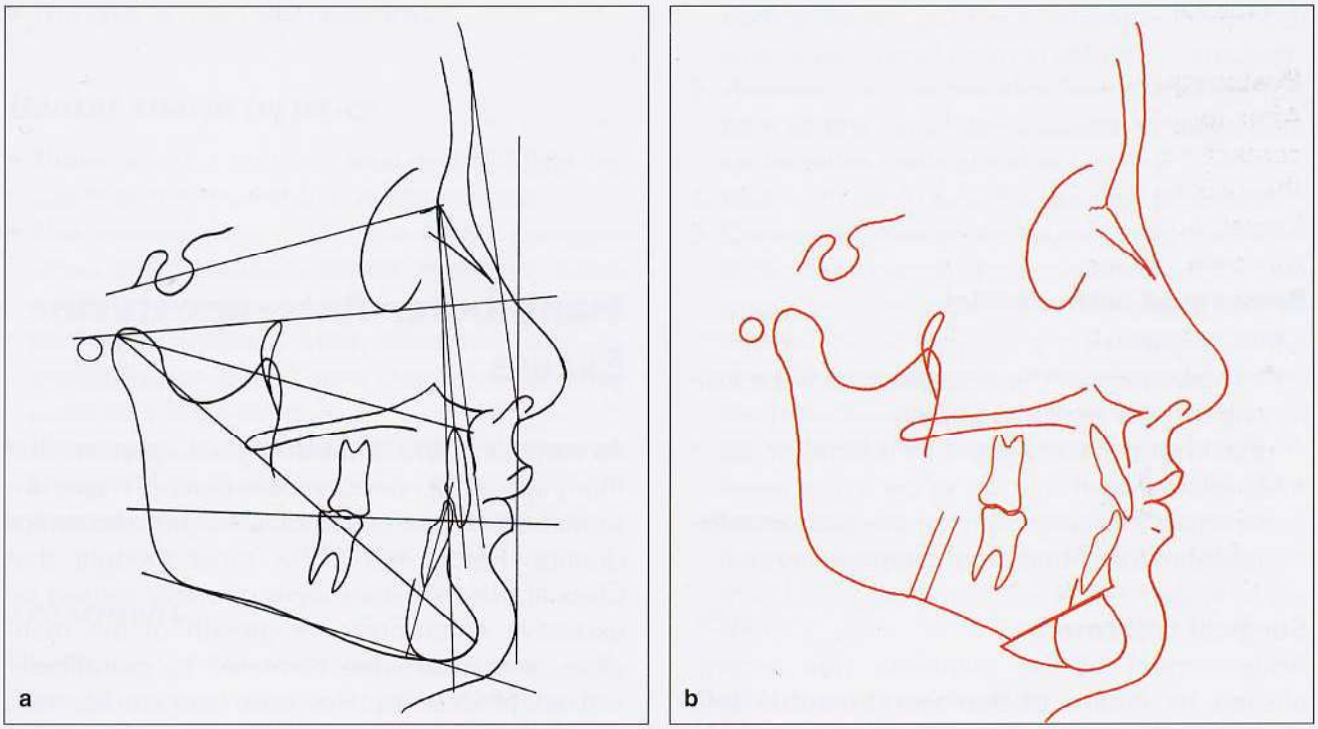


Fig 4-14 Case T.G. Pretreatment cephalometric analysis *(a)* and cephalometric prediction tracing *(b)*.

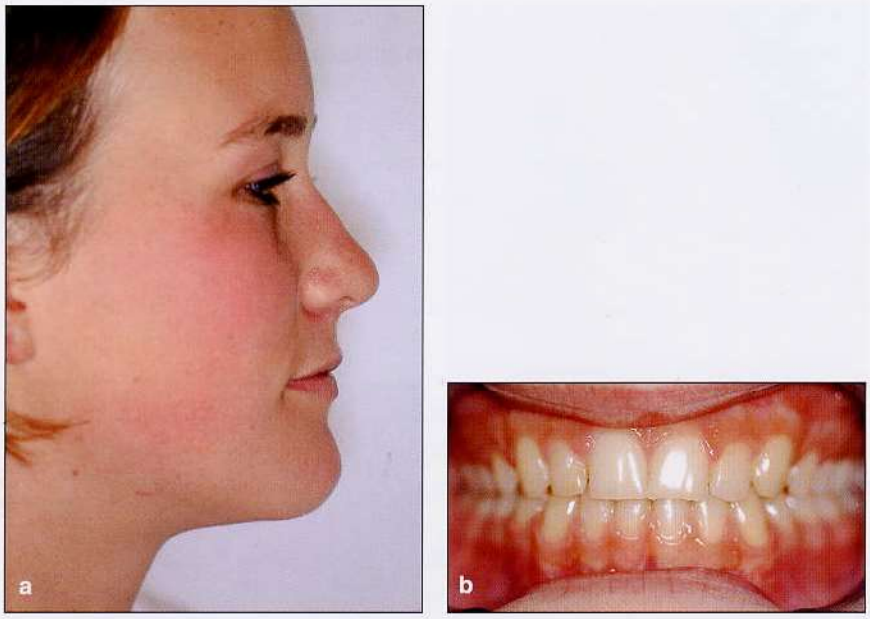


Fig 4-15 Case T.G. Posttreatment profile view *(a)* and occlusion *(b)*.

Presurgical orthodontics

- Maxillary arch
  - Improvement of the angulation of the maxillary incisors by labial tipping
  - Establishment of a good arch form
- Mandibular arch
  - Leveling and alignment of the arch and establishment of interarch compatibility

Surgical treatment

Advancement of the mandible was accomplished by means of a bilateral sagittal split ramus osteotomy, and the chin was anteroposteriorly reduced using a sliding genioplasty (Fig 4-14b).

Postsurgical orthodontics: Refinement of the occlusion and retention

The surgery was performed after an 18-month orthodontic preparatory phase and the orthodontic bands removed 3 months after surgery. The posttreatment results are illustrated in Fig 4-15.

Mandibular Anteroposterior Excess

As early as 1907, Edward Angle suggested that the only way to correct severe Class III malocclusion in adults was to combine surgery and orthodontics. Before the 1970s most thought that Class III malocclusions were primarily caused by excessive anteroposterior growth of the mandible, and most were corrected by mandibular setback procedures. However, later studies indicated that isolated mandibular anteroposterior excess occurs in only approximately 20% to 25% of Class III cases. Some maxillary skeletal anteroposterior deficiency is involved in 75% of cases with Class III malocclusions. Therefore, in Class III cases the clinician must determine whether one jaw is primarily at fault or a combination of maxillary deficiency and mandibular excess is causing the malocclusion.

Class III malocclusion

Clinical characteristics

Profile view

- There is a long chin-throat length with a well-defined inferior border of the mandible.
- A protrusive chin results in a prominent lower third of the face.
- The labiomental fold is reduced.
- The lip-chin-throat angle is acute.

Frontal view

- The lower third of the face appears "flat."
- The chin button is not prominent.
- A thin upper lip has reduced vermillion exposure.
- The labiomental fold is reduced.
- The mandible appears strong.
- The chin is often asymmetrical.

Dental characteristics

- There is often minimal attached gingival tissue over the mandibular anterior teeth.
- The mandibular incisors are often compensated and lingually inclined. However, some patients have generalized interdental spacing and flared incisors, often combined with an anterior open bite. These characteristics may point to a large tongue.
- There is a Class III malocclusion with anterior and posterior crossbites.
- A dental midline discrepancy is often present.

Treatment

The timing of treatment of adolescents with Class III malocclusion is important. Many patients with severe Class III dentofacial deformities want definitive treatment as soon as possible, and early treatment may be desirable from a social and psychologic point of view. However, if surgery is performed before completion of mandibular growth, the malocclusion is likely to recur as a result of growth.

Maxillary growth may be completed at age 15 or even age 14; therefore, when maxillary deficiency is the primary problem, delaying surgery until completion of growth is usually a feasible option. However, mandibular growth may continue until the early 20s. Some patients with severe mandibular excess are not willing to wait and elect to have surgery earlier, recognizing the fact that a second procedure may be necessary later. Case C.M., discussed later in the chapter, is an example of a case where surgery was offered to the patient before the completion of growth.

Presurgical orthodontics

Orthodontic preparation prior to surgery has five basic goals:

1. Eliminate (or reduce) anterior and posterior dental compensation with guidance from the orthodontic visual treatment objective.
2. Establish appropriate anteroposterior and vertical incisor positions. Improper incisor positions will curtail optimal esthetic correction.
3. Achieve compatible arch forms and intercanine widths, which are essential to make dental midlines compatible at surgery.
4. Deal with tooth size discrepancy problems.
5. Correct the mandibular asymmetries that often accompany mandibular prognathism. If the chin shape is acceptable, the mandibular dental midline should be placed in the middle of the chin. The asymmetry will be corrected during the mandibular setback procedure. It also can be corrected by a genioplasty, if one is indicated to correct poor chin shape or vertical or anteroposterior chin deformities. Thus, it is not always necessary to orthodontically place the mandibular dental midline in the midline of the chin.

Orthodontic mechanics

Mandibular arch The following techniques are recommended for orthodontic treatment of the mandibular arch:

1. Class III mechanics, including molar tie-backs, are not used when leveling, and the teeth are allowed to level forward. The orthodontic visual treatment objective should be refered to regularly to confirm the extent of incisor decompensation required.

2. On completion of leveling, Class II elastics may be used to advance the mandibular buccal segments and further procline the mandibular incisors. This movement should be monitored on sequential cephalometric films.
3. Arch length discrepancies should be reconciled with the desired mandibular incisor position.
4. When decompensating the mandibular incisors, the clinician should bear in mind that patients with mandibular anteroposterior excess often have a very thin, bony symphysis and a small area of attached gingiva in the incisor region.

Maxillary arch For orthodontic treatment of the maxillary arch, the following approach is recommended:

1. High-pull headgear should be applied to the maxillary incisor area nightly. This should be used with Class II mechanics to prevent extrusion of the maxillary incisors when advancing the mandibular dentition.
2. Headgear anchorage should aid retraction of the maxillary incisors or merely prevent their proclination during the leveling process.

Surgical treatment

Bilateral sagittal split osteotomy is the procedure of choice, although a transoral vertical ramus osteotomy may be indicated in cases requiring large setback procedures.

Correct positioning of the condyle is very important. The surgeon should carefully free the medial pterygoid muscle and the stylomandibular ligament from the medial side of the ramus. Otherwise, the proximal segment will be pushed back by the distal (tooth-bearing) segment, leading to a backward rotation of the ramus. With the return of muscle function, the patient will tend to position the mandible forward again.

If bicortical screws are used for rigid fixation, positional self-tapping screws are preferred to maintain bone segment positions. With setback procedures, especially where simultaneous correction of asymmetry is required, small intersegmental defects may develop. If these defects are closed by tightening the screws, the torquing effect will displace the condyles laterally (peripheral condylar sag; see the discussion of condylar sag in chapter 5).

The incidence of neurosensory morbidity with transoral vertical ramus osteotomy is less than that associated with a bilateral sagittal split ramus osteotomy, but the procedure carries an increased risk of poor condylar control.

On rare occasions, procedures such as body ostectomies or segmental subapical osteotomies are indicated to correct mandibular anteroposterior excess.

A genioplasty is often indicated to place the chin in its most esthetic anteroposterior, vertical, and midsagittal positions. The labiomental fold is often obtuse in Class III cases; reduction genioplasty would make this angle more obtuse, causing the chin to appear flat and resulting in an overall poor esthetic result. Chin shape is more important than the anteroposterior position of soft tissue pogonion.

Postsurgical orthodontics

Postsurgical orthodontics for Class III cases is very similar for all patients. In Class III open bite cases, the occlusion should be prepared presurgically so that the only postsurgical orthodontic tooth movements required are those with little or no potential to open the bite.

If a tendency to relapse is noticed, light (2.5- to 3.5-oz) Class III elastics should be placed immediately. A rectangular archwire should be in place in the maxilla to prevent molar extrusion.

The clinician should design the retention plan according to the original malocclusion and its possible relapse tendency.

Case D.G.

A 19-year-old male patient was referred to the orthodontist by his general practitioner for the correction of an open bite.

Main complaint

The patient said he was unable to bite properly, and the flat appearance of his midface bothered him.

Fig 4-16 Case D.G. Pretreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

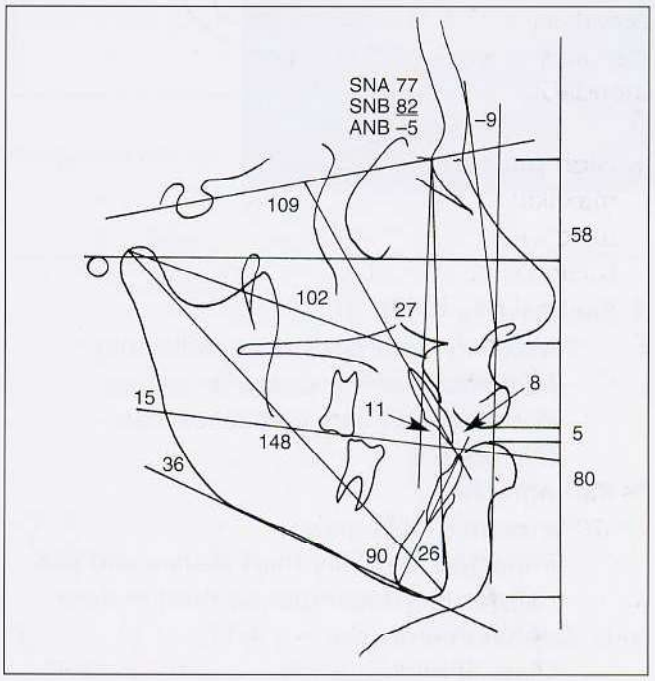


Fig 4-17 Case D.G. Pretreatment cephalometric analysis. Maxillary anteroposterior deficiency: SNA = 77 degrees; Class III skeletal relationship: ANB = –5 degrees; concave profile: facial contour angle = –9 degrees.

Medical history

The patient had asthma. He had contracted hepatitis A at age 15 and recovered satisfactorily.

Clinical examination

1. Soft tissue
   a. Frontal view (Fig 4-16a)
      - Deficient paranasal areas
      - Increased interlabial distance
      - Excessive lower lip vermilion exposure

   b. Profile view (Fig 4-16b)
      - Concave profile
      - Midface deficiency
      - Everted lower lip
      - Increased interlabial distance
      - Deficient chin
2. Dental (Fig 4-16c)
      - Class III malocclusion
      - Anterior open bite
      - Slightly compensated mandibular incisors

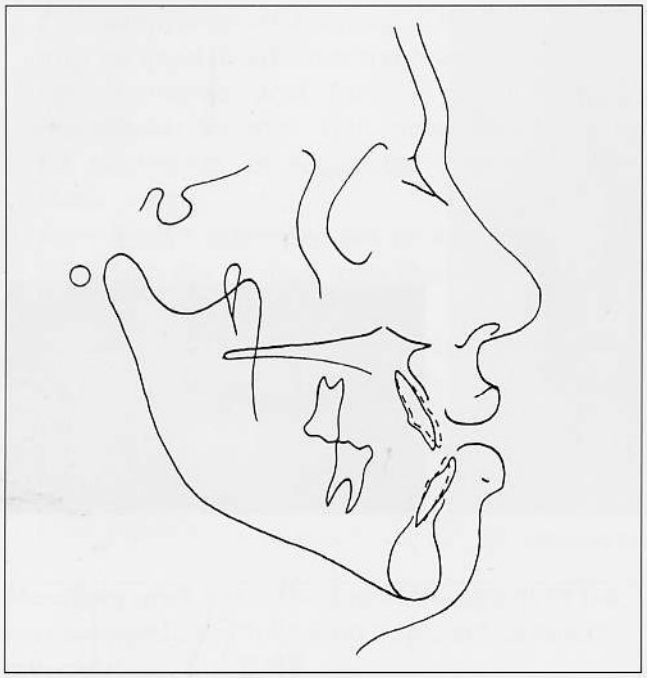


Fig 4-18 Case D.G. Orthodontic change: decompensation of the incisors.

3. Skeletal (Fig 4-17)
   - Maxillary anteroposterior deficiency
   - Mandibular anteroposterior excess
   - Posterior maxillary vertical excess
   - Micrognenia
4. Radiographic
   a. Panoramic radiograph
      - Impacted maxillary third molars and partially erupted mandibular third molars
   b. Cephalometric (see Fig 4-17)
      - Class III malocclusion
      - Class III skeletal relationship
      - Maxillary anteroposterior deficiency
      - Anterior open bite
      - Slightly lingually inclined incisors
      - Lack of dental support for the upper lip
      - Everted lower lip
      - Mandibular anteroposterior excess
      - Flat chin

Problem list

1. Class III malocclusion
2. Maxillary anteroposterior excess
3. Posterior maxillary vertical excess
4. Incisor compensation

Presurgical orthodontics

- Maxillary arch (Figs 4-18 and 4-19)
  - Removal of the third molars
  - Leveling and alignment of the arch
  - Establishment of arch compatibility with the mandibular dental arch
  - No attempt to close the open bite by extrusion of incisors or by intrusion or expansion of posterior teeth
- Mandibular arch (see Figs 4-18 and 4-19)
  - Removal of the third molars
  - Leveling and alignment of the arch
  - Creation of a slight decompensation of incisors

Surgical treatment

A Le Fort I maxillary osteotomy was used to advance the maxilla by 3 mm. At the same time, the maxilla was superiorly repositioned 3 mm anteriorly (to establish the ideal tooth-lip relationship) and 6 mm posteriorly (to allow the mandible to autorotate) (Fig 4-20).

Because autorotation of the mandible worsened the Class III relationship, the mandible was set back 8 mm by means of a bilateral sagittal split ramus osteotomy.

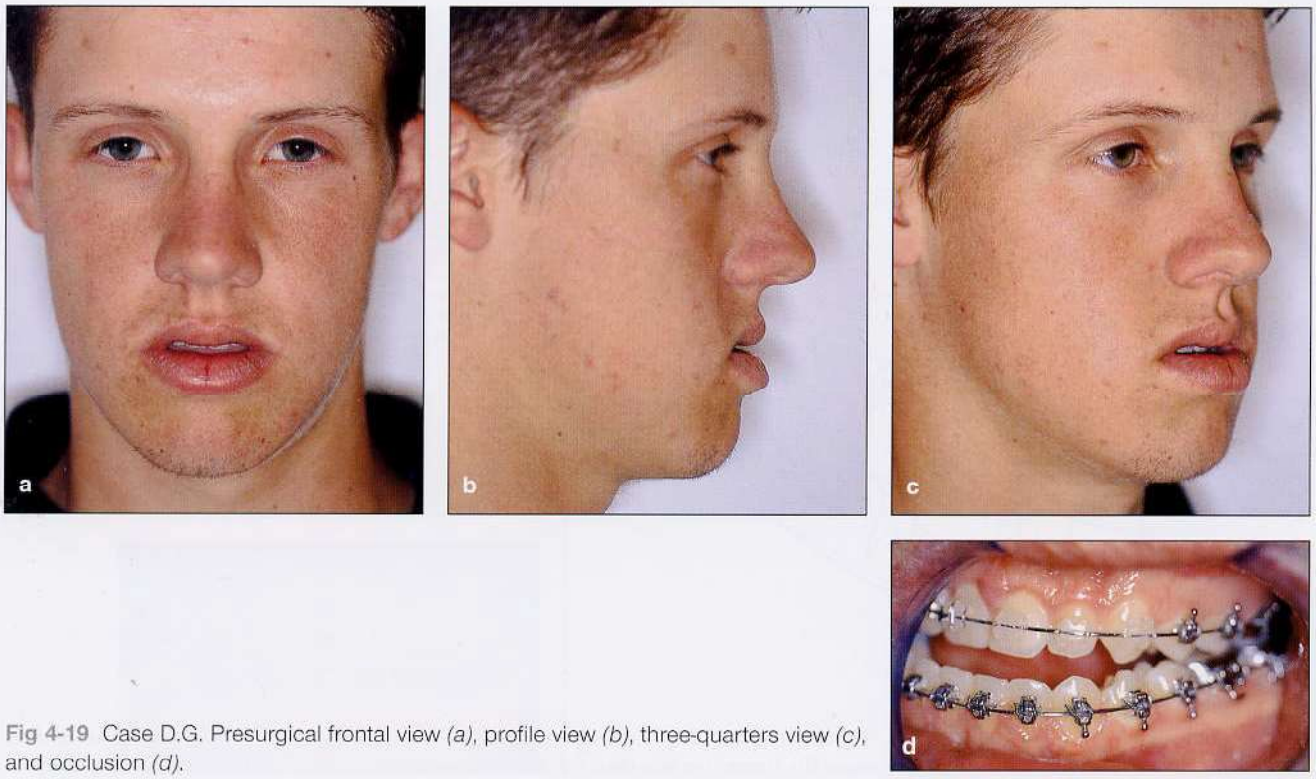


Fig 4-19 Case D.G. Presurgical frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

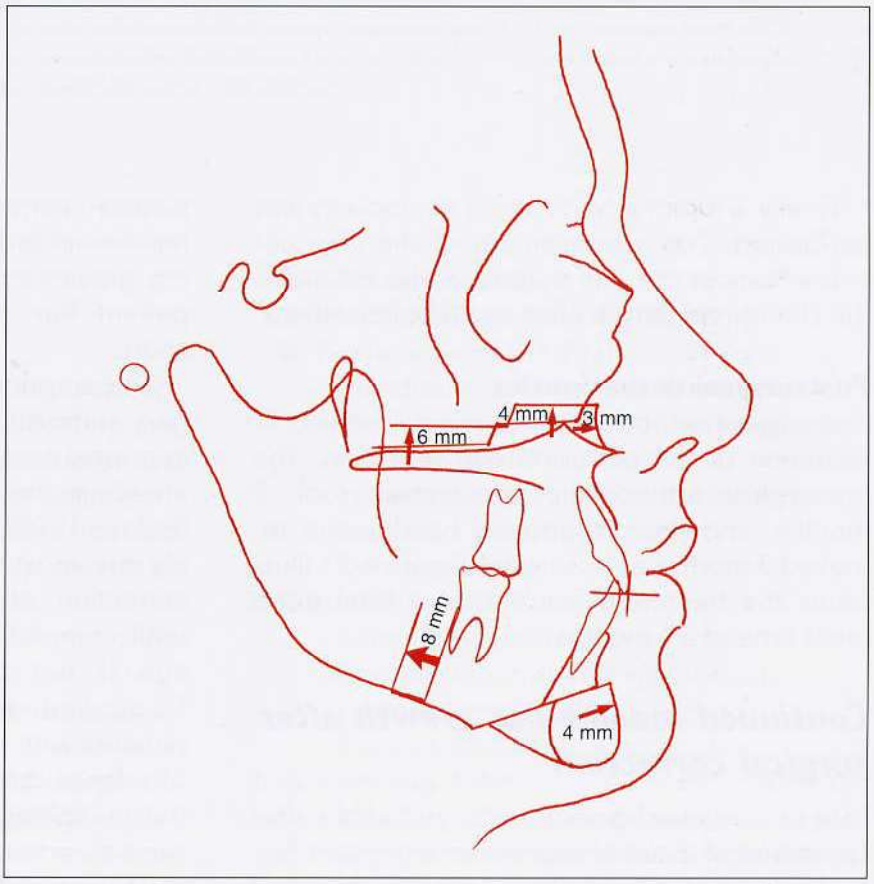


Fig 4-20 Case D.G. The surgical visual treatment objective includes maxillary superior repositioning with advancement, mandibular setback, and advancement genioplasty.

Fig 4-21 Case D.G. Posttreatment results are demonstrated in frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

Finally, a 4-mm advancement genioplasty was performed. The advancement of the chin not only enhances the chin shape but also maintains the chin-throat length after mandibular setback.

Postsurgical orthodontics

Postsurgical orthodontic treatment involved finalization of the occlusion and retention. The presurgical orthodontic preparation took 8 months, and the orthodontic bands were removed 3 months after surgery. Figure 4-21 illustrates the treatment result after a total treatment time of 11 months.

Continued mandibular growth after surgical correction

Late or continued growth of the mandible after correction of Class III cases is an important factor in postsurgical stability, so the clinician must ensure that facial growth is completed prior to surgical correction. Serial cephalograms and hand-wrist radiographs are helpful in monitoring growth and estimating whether a growing patient has experienced his or her growth spurt.

The surgeon may consider performing surgery before the completion of growth in exceptional cases, since "biological interest is not always in the patient's psychological interest" (Enlow, 1990). Ages 12 to 19 years are probably the most formative, and to postpone the correction of severe dentofacial deformities until completion of growth in individuals this age is not best for them psychologically. Surgical correction should be offered to these patients with the full understanding of the risk of relapse due to the continued growth. Upon the completion of growth, surgical correction can be performed. The following case illustrates a satisfactory outcome to the above problem.

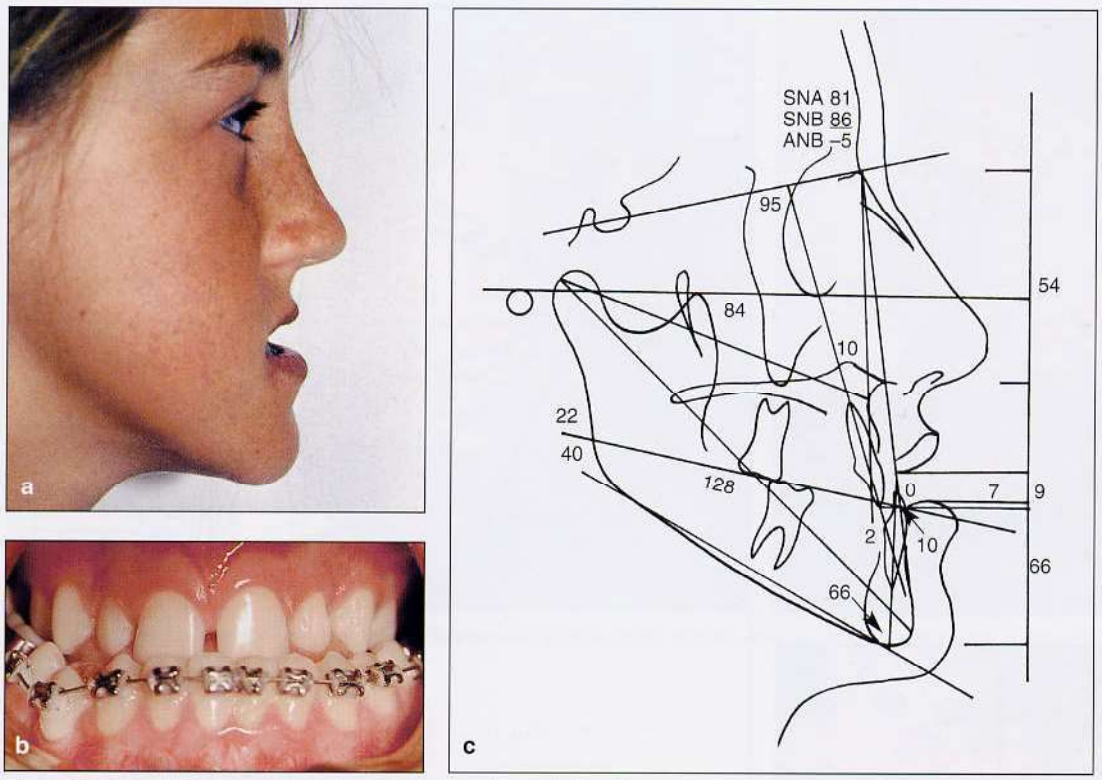


Fig 4-22 Case C.M. Pretreatment profile view *(a)*, occlusion *(b)*, and cephalometric analysis *(c)* 1 week after banding the mandibular arch (age, 12 ½ years). Class III skeletal relationship: ANB = –5 degrees, mandibular length to maxillary length = 84:128 mm; maxillary vertical excess: interlabial gap = 7 mm, maxillary tooth exposure under the upper lip = 9 mm; compensated mandibular incisors: mandibular incisor to N-B = 0 mm and 10 degrees, mandibluar incisor to mandibular plane = 66 degrees.

Case C.M.

Main complaint

According to the patient's parents, her facial appearance was a burden to her, affecting her schoolwork and social life. She was unhappy and was teased by her peers about her large mandible. She was also concerned about the fact that the unfavorable jaw relationship caused an increasingly severe speech problem.

Medical history

Her medical history was noncontributory.

Clinical examination

1. Soft tissue
   a. Frontal view
      - Increased interlabial distance
      - Unsupported upper lip that appears flat
      - Prominent chin
      - Increased lower facial height
   b. Profile view (Fig 4-22a)
      - Mandibular anteroposterior excess
      - Maxillary anteroposterior deficiency
      - "Gummy smile"
      - Increased maxillary incisor exposure
      - Increased lower facial height
      - Concave profile
2. Dental (Fig 4-22b)
   - Class III malocclusion
   - Compensated mandibular incisors
   - Posterior crossbites
   - Canines partially blocked out
3. Skeletal (Fig 4-22c)
   - Maxillary vertical excess
   - Maxillary anteroposterior deficiency
   - Mandibular anteroposterior excess

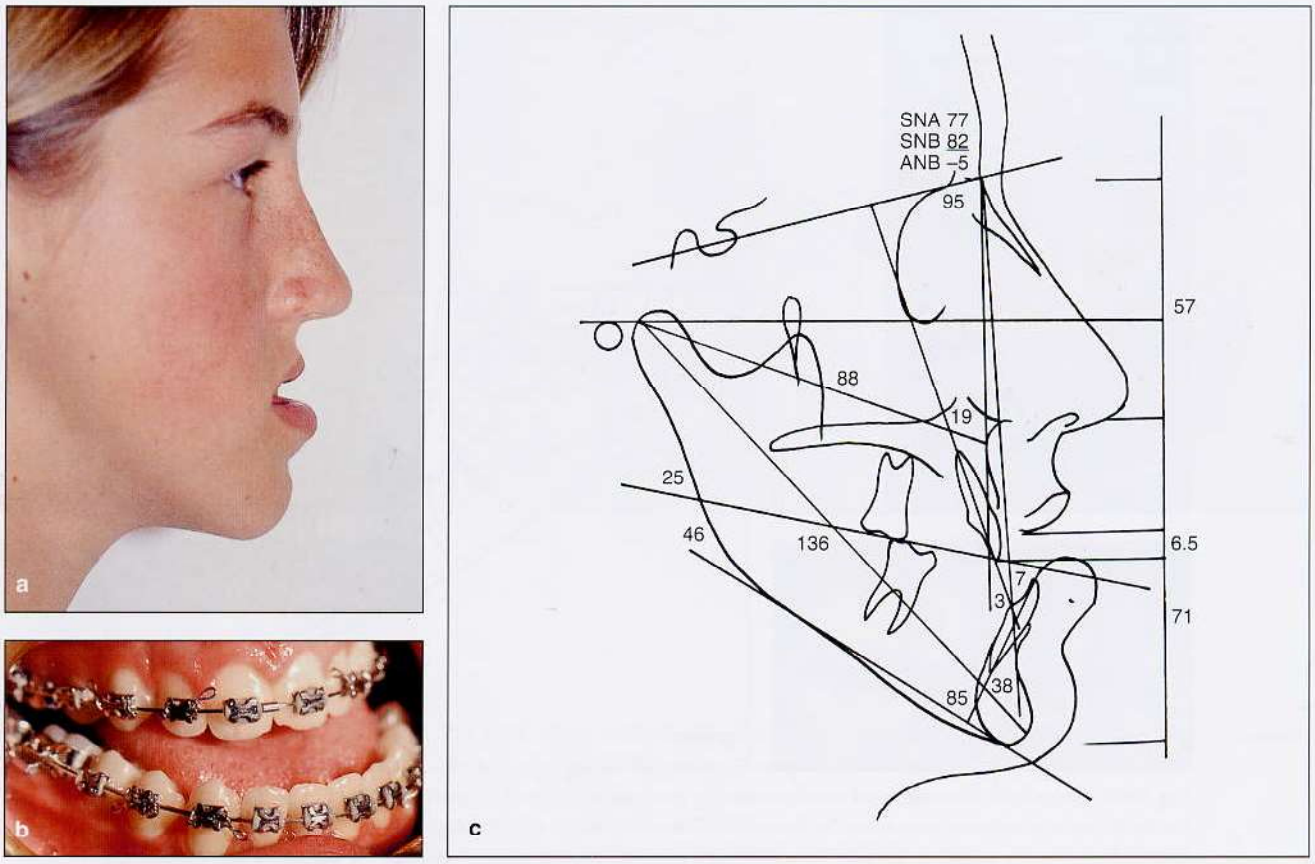


Fig 4-23 Case C.M. Immediate presurgical profile view *(a)*, occlusion *(b)*, and cephalometric tracing *(c)*. Note the profound anteroposterior and vertical growth.

4. Radiographic (see Fig 4-22c)
   a. Hand-wrist radiography
      - Patient still actively growing
   b. Cephalometric
      - Confirms the clinical observations

Problem list

1. Vertical maxillary excess
2. Maxillary anteroposterior deficiency
3. Mandibular anteroposterior excess
4. Class III malocclusion
5. Blocked-out maxillary canines
6. Compensated mandibular incisors
7. Patient still actively growing

Presurgical orthodontics

- Maxillary arch
  - Extraction of both maxillary first premolars
  - Arch alignment and closure of the spaces
  - Movement of the canines into the arch
- Mandibular arch
  - Decompensation of the incisors
  - Leveling of the curve of Spee
  - Establishment of interarch compatibility

The profound vertical and anteroposterior growth during orthodontic treatment is evident when the pretreatment (see Fig 4-22) and immediate presurgical records (Fig 4-23) are compared.

Surgical treatment

- A Le Fort I osteotomy that superiorly repositioned the maxilla (6 mm anteriorly and posteriorly), rotating the maxillomandibular complex slightly clockwise (Fig 4-24a) (see the section on rotation of the maxillomandibular complex, pages 201 to 213)
- Maxillary advancement (8 mm) (see Fig 4-24a)
- A bilateral sagittal split ramus osteotomy setting the mandible back (12 mm) (see Fig 4-24a)

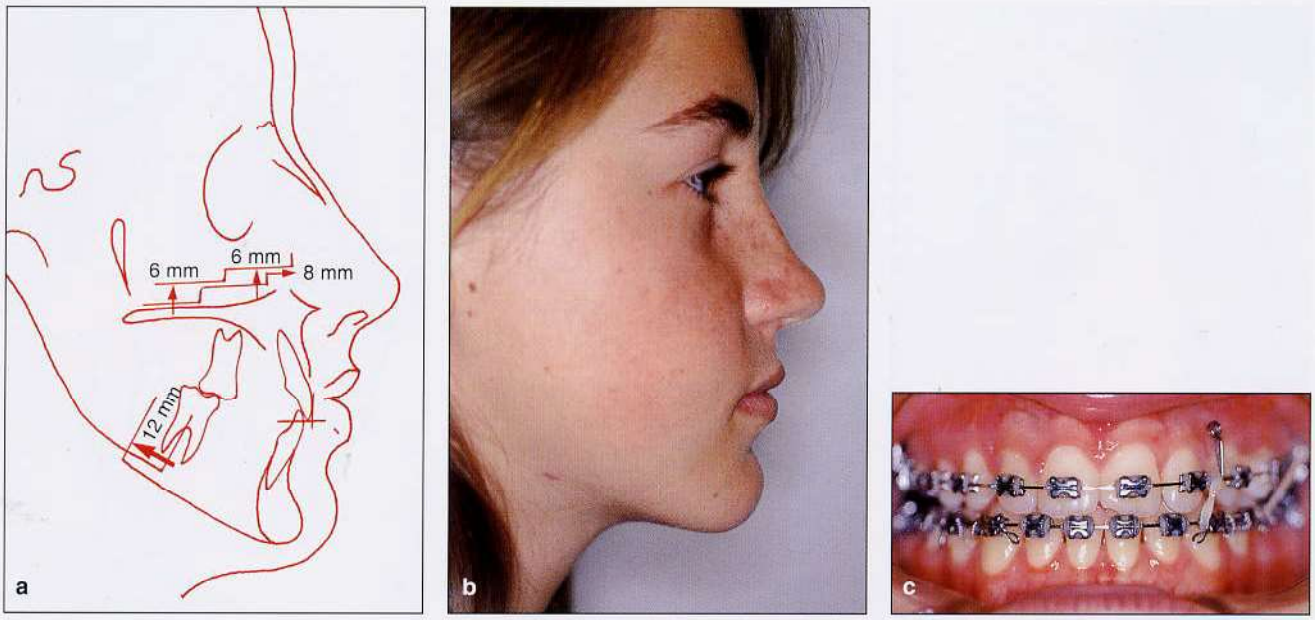


Fig 4-24 Case C.M. *(a)* Surgical prediction tracing. *(b)* Immediate postsurgical profile view. *(c)* Immediate postsurgical occlusion.

The surgical movements are large. This, along with the fact that the surgery is performed on a growing individual, makes the relapse potential significant in this case.

Postsurgical orthodontics

Postsurgical orthodontic treatment entails finalization of the occlusion and retention. In this case, the postsurgical skeletal change should be accurately monitored, and the dentition not compensated for any relapse or further growth. When surgery is performed early and further excessive mandibular growth is expected, the dentition should not be orthodontically compensated for this growth because *(1)* it will disguise the skeletal growth and *(2)* the teeth will need to be decompensated again before final surgical correction.

The postoperative results are demonstrated in Figs 4-24b and 4-24c. Postsurgical growth is evident in Fig 4-25 (10 months after surgery) and Fig 4-26 (4 years after surgery). Five years after the initial correction, the clinician decided to perform the final correction. After a short period of orthodontic treatment to decompensate the mandibular incisors slightly (Fig 4-27), the mandible was set back by means of a bilateral sagittal split osteotomy. The final result is illustrated in Fig 4-28 (1 year after the second surgery). This patient certainly benefited from early surgery, even though a second surgical procedure had to be performed 5 years after the initial correction. The fact that the bicortical screws had to be removed prior to performing the bilateral sagittal split osteotomy made the second surgery challenging. To facilitate this procedure, the use of resorbable fixation at the first surgery is indicated.

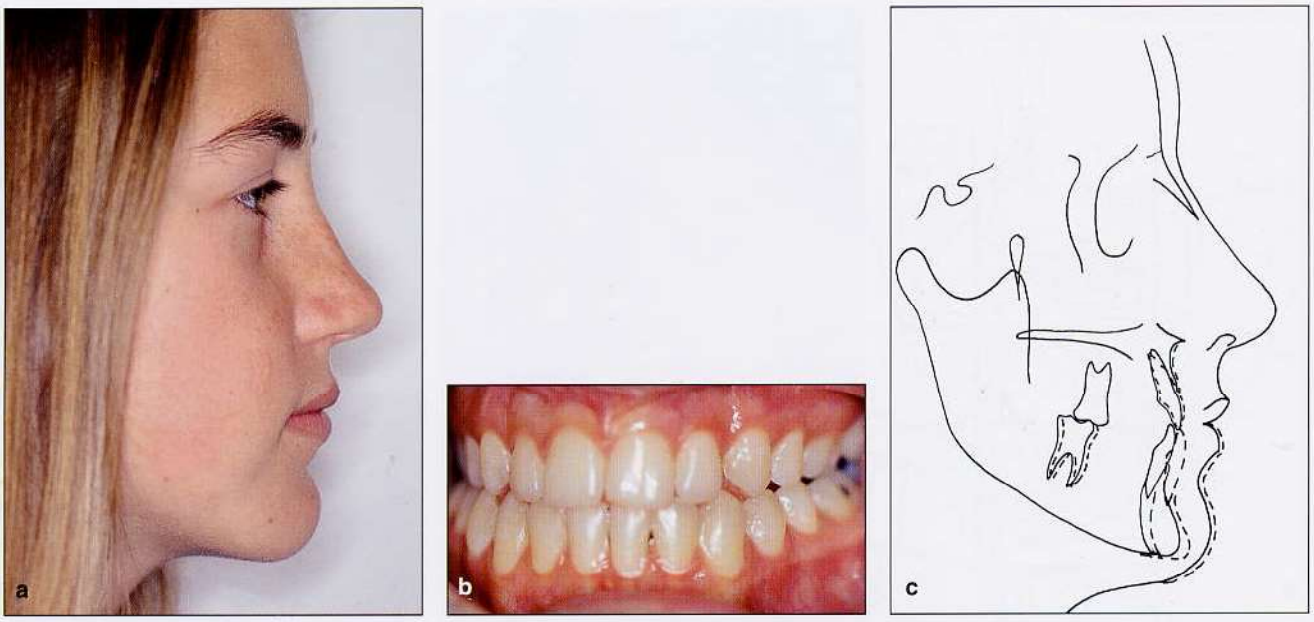


Fig 4-25 Case C.M. Relapse is evident 10 months after surgery. *(a)* Profile view. *(b)* Occlusion. *(c)* Cephalometric tracing indicating some signs of further mandibular growth.

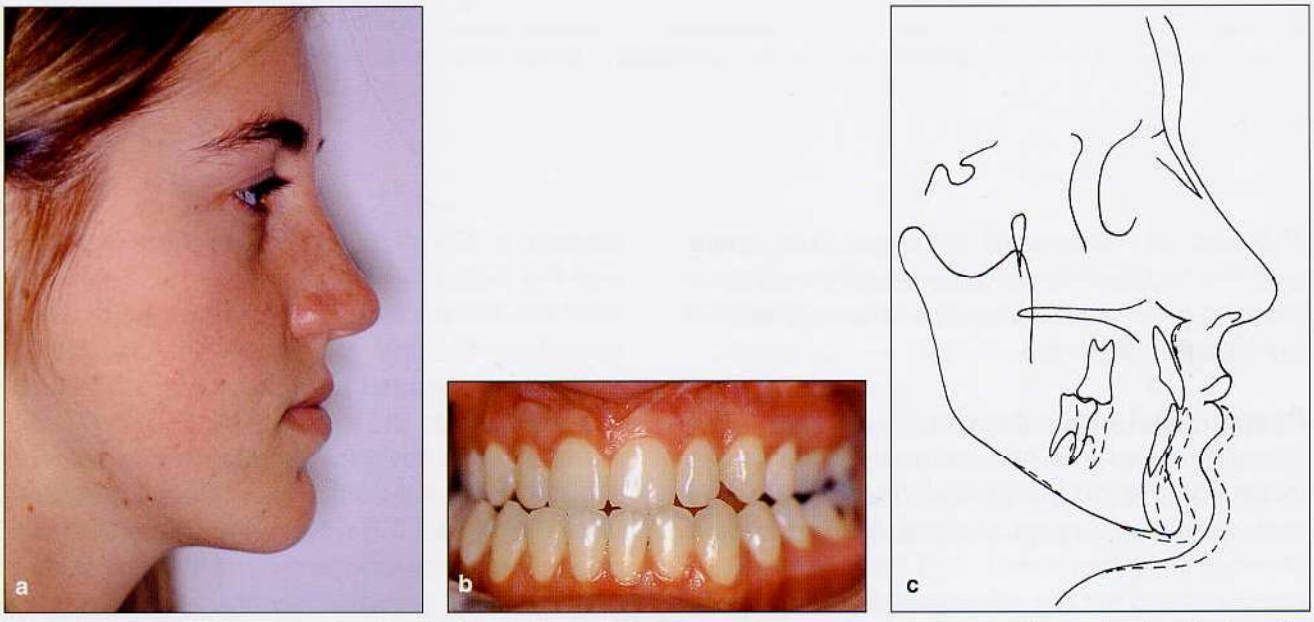


Fig 4-26 Case C.M. Four years after the initial correction, a Class III malocclusion is present. The maxilla remained stable. A profile view *(a)*, the occlusion *(b)*, and a cephalometric tracing *(c)* illustrate the further growth of the mandible.

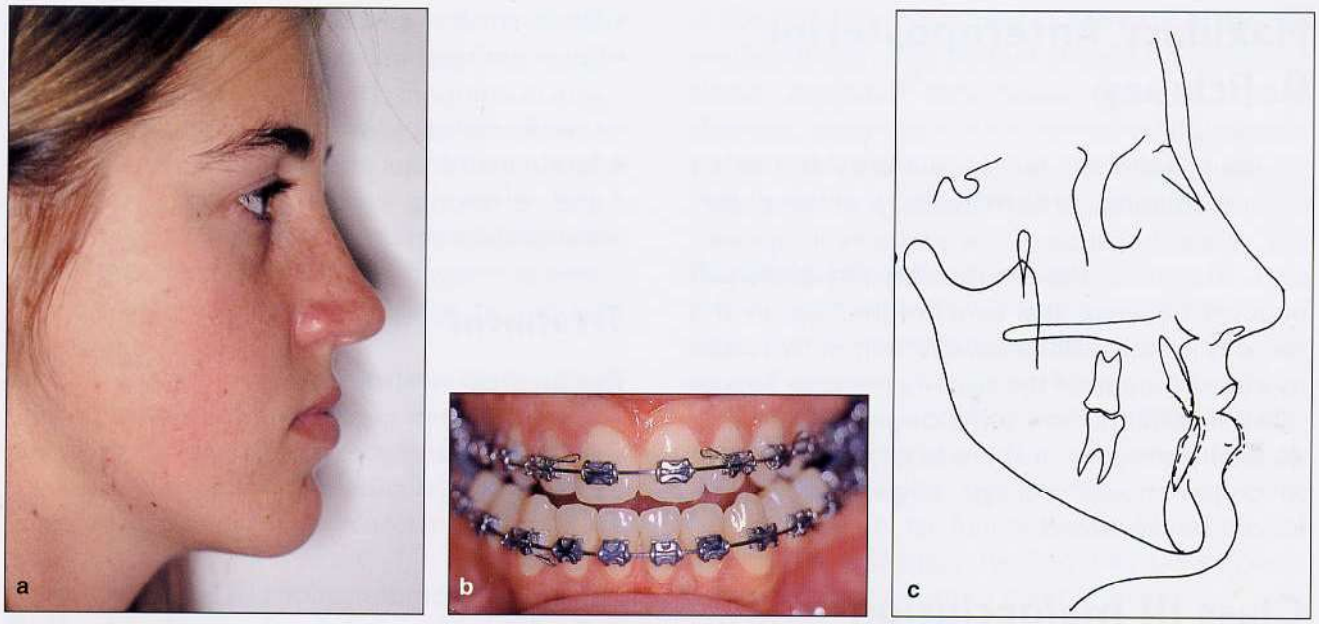


Fig 4-27 Case C.M. The decompensation of the mandibular incisors is completed before the second corrective procedure. *(a)* Profile view. *(b)* Occlusion. *(c)* Cephalometric tracing.

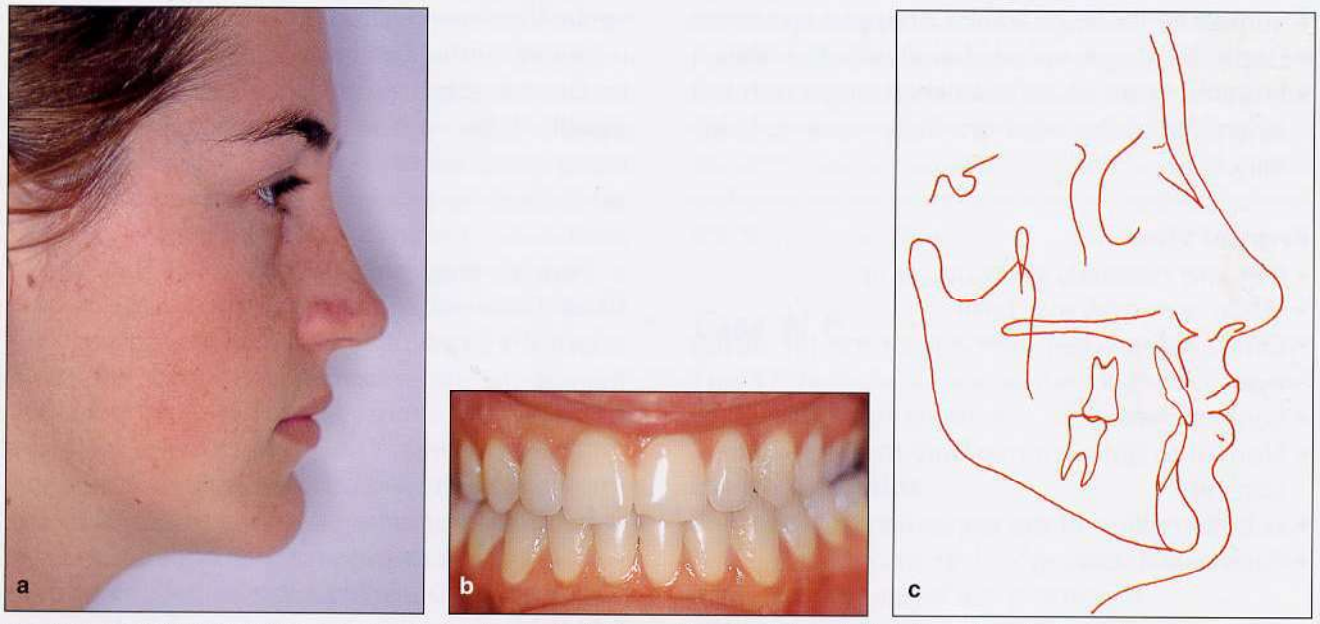


Fig 4-28 Case C.M. Posttreatment results are demonstrated in profile view *(a)*, occlusion *(b)*, and cephalometric tracing *(c)* 1 year after the second surgical procedure.

Maxillary Anteroposterior Deficiency

Maxillary anteroposterior deficiency has often been misdiagnosed as mandibular anteroposterior excess because of the similarity in appearance. Therefore, the clinician must carefully distinguish between the two deformities. In the majority of Class III cases, the deformity is due to a combination of the two. As many as 75% of Class III patients have some degree of maxillary skeletal deficiency. If there is any doubt about which jaw should undergo surgery, the maxilla should be advanced.

Class III malocclusion

Clinical characteristics

Profile view
- Sunken cheeks
- Chin and lower lip in balance with nose
- Sunken or flat appearance of upper lip
- Upper lip length reduced and vermillion thin
- Frequently, an acute nasolabial angle with the columella of the nose oriented more horizontally

Frontal view
- Flat and relatively short upper lip
- Often, a narrow alar base
- Often, sclera seen inferiorly of the iris of the eye
- Sunken cheeks
- Normal to deficient maxillary tooth-to-lip relationship
- Less vermillion of the upper lip showing
- Paranasal flattening

The relationship of each individual jaw to the cranium can be evaluated clinically by blocking out the mandible and then the maxilla with a hand or card.

Dental characteristics

- Class III malocclusion
- Often, crowding in the maxillary arch
- Often, small or absent maxillary lateral incisors
- Often, normal inclination of mandibular incisors in comparison with the lingual inclination seen in mandibular anteroposterior excess
- Tendency of the maxillary arch to be narrow and often in lingual crossbite with the mandibular arch

Treatment

Presurgical orthodontics

The treatment of maxillary anteroposterior deficiency has the same basic goals as does the treatment of mandibular anteroposterior excess:

1. Eliminate compensations.
2. Establish ideal incisor position (indicated by the orthodontic visual treatment objective).
3. Establish arch compatibility.
4. Level and align arches.

It is important to keep in mind that the transverse discrepancy that often accompanies the maxillary anteroposterior deficiency may have to be corrected by surgical expansion of the maxilla. If this is contemplated, the arch should be aligned accordingly and the roots of the teeth next to the interdental osteotomy deviated.

Two-jaw surgery may be indicated in severe Class III cases. Here the orthodontist should adopt the "two-patient" concept, in which the mandibular and maxillary arches are treated independently, almost as if they belong to two different patients. The objective is to align the maxillary and mandibular incisors in both vertical and anteroposterior planes of space so the surgeon can achieve optimal skeletal and esthetic correction without the limitations of dental interference.

Cases of maxillary deficiency often involve crowding in the maxilla, and retraction of incisors is indicated. This will necessitate extractions, which follow these principles:

1. If maximum retraction is necessary or significant crowding is present, removal of maxillary first premolars is indicated.

2. If little retraction is necessary and crowding is slight, removal of second premolars is indicated.
3. Advancement of mandibular incisors from an upright or lingually tipped position may be limited by lack of attached gingiva and/or a thin alveolar bone and symphysis. Mandibular second premolar extraction may be necessary to provide the required space to manage crowding.
4. The most common extraction pattern in Class III cases is extraction of maxillary first premolars and, when extraction in both arches is indicated, extraction of maxillary first premolars and mandibular second premolars (the opposite of Class II cases).

Orthodontic mechanics

Crowding is often present in the maxillary arch and requires tooth extraction. The canines are usually blocked out, which is often the patient's main complaint before treatment. The decision whether to extract the first or second premolars is influenced by the amount of crowding and required decompensation of the incisors. Presurgically, the maxillary incisors should be placed in good angulation in the central trough of bone. To achieve the best esthetic result, their anteroposterior positioning should be based on the visual treatment objective. Decompensation of the mandibular incisors is seldom indicated. The mandibular arch should be leveled and aligned so as to act as the "template" for the maxillary dental arch.

Surgical treatment

The maxilla is advanced by means of a Le Fort I osteotomy. This versatile procedure enables the surgeon to correct discrepancies in the vertical, transverse, and occlusal planes. Grafting is recommended both in cases with large advancements and cases with expansion of the palate. Various grafting materials are available, including bone harvested from local or distant sites, including the chin or iliac crest; allogenic freeze-dried bone; and artificial bone substitutes such as hydroxyapatite blocks.

Undesirable soft tissue changes may occur, including widening of the alar base, tipping up of the tip of the nose, and an increase in the nasolabial angle. The patient should be informed about expected soft tissue changes. These changes, however, can be controlled (for details on surgical technique, see the section on Le Fort I maxillary osteotomy in chapter 5).

Postsurgical orthodontics

Postsurgical orthodontic treatment is very similar to that of mandibular setback cases. A splint is used only when a multipiece Le Fort I maxillary osteotomy is performed. In two-jaw surgery, an intermediate splint is always used to accurately position the maxilla. The patient would be able to function with the occlusal splint until adequate healing has taken place and active orthodontics can be resumed.

Ligature wires between teeth adjacent to interdental osteotomies should be placed by the surgeon and be removed only by the orthodontist during the placement of a continuous archwire.

When surgical expansion has been performed, the transverse dimension should be maintained by an occlusal splint reinforced by a palatal bar. The palatal bar prevents bending of the splint during and after surgery. Once the splint is removed, the orthodontist should place an orthodontic palatal bar and a continuous archwire as soon as possible to further control the transverse dimension.

Case M.P.

This 17-year-old female patient was seen by the orthodontist for alignment of her teeth.

Main complaint

The patient wanted her teeth aligned and her "bad bite" corrected. She also felt that her mandible appeared too prominent.

Medical history

Her medical history was noncontributory.

Clinical examination

1. Soft tissue
   a. Frontal view (Fig 4-29a)
      - Flat paranasal areas
      - Lack of upper lip support

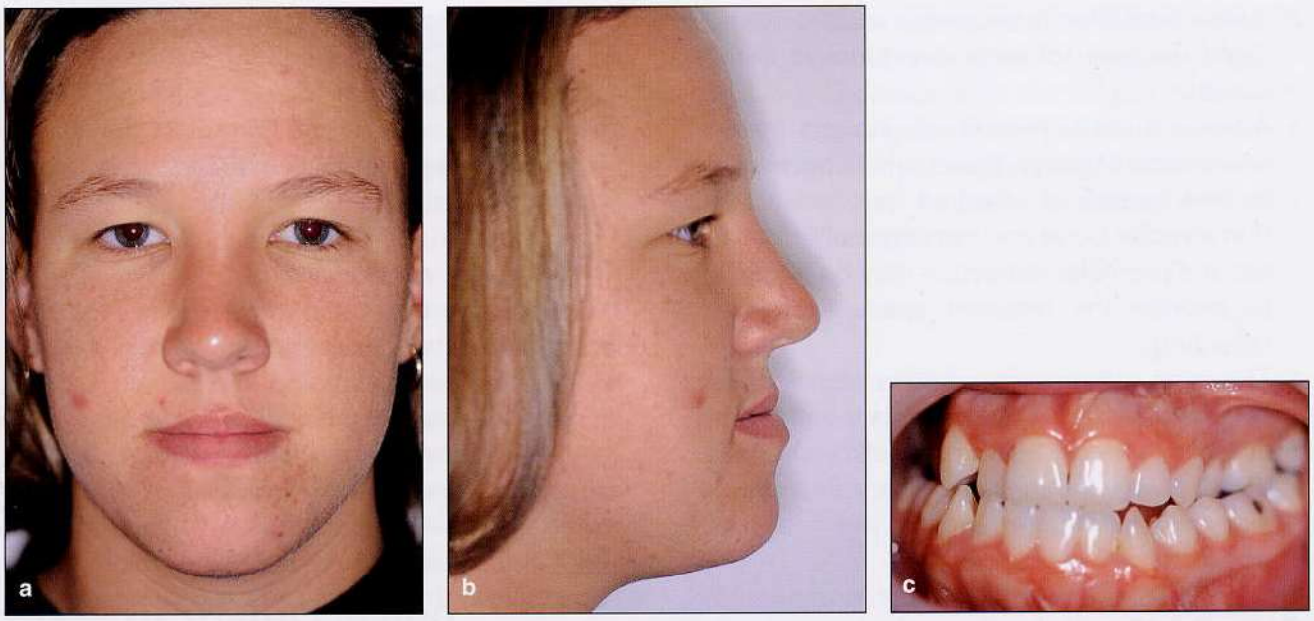


Fig 4-29 Case M.P. Pretreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

- Relatively small amount of upper lip vermilion exposure

b. Profile view (Fig 4-29b)
- Concave profile
- Lack of upper lip support
- Lower lip ahead of the upper lip
- Obtuse labiomental fold
- Acute nasolabial angle

2. Dental (Fig 4-29c)
- Class III malocclusion
- Anterior and posterior crossbites (absolute)
- Compensated mandibular incisors
- Narrow maxillary dental arch
- Maxillary dental midline 1.5 mm toward the left
- Maxillary left first premolar absent
- Crowding in the maxillary and mandibular arches

3. Skeletal (Fig 4-30)
- Maxillary anteroposterior deficiency
- Maxillary transverse deficiency
- Vertical excess of the anterior mandible
- Tendency toward anteroposterior deficiency of the chin

4. Radiographic

a. Panoramic radiograph
- Maxillary left first premolar absent
- Four impacted third molars

b. Cephalometric (see Fig 4-30)
- Confirms clinical observations

Problem list

1. Class III malocclusion
2. Maxillary anteroposterior deficiency
3. Maxillary transverse deficiency
4. Maxillary dental midline toward the left
5. Lingually inclined mandibular incisors
6. Anterior mandibular vertical excess

Presurgical orthodontics

- Maxillary arch (Fig 4-31)
  - Extraction of the maxillary right first premolar and removal of impacted third molars
  - Correction of the dental midline
  - Establishment of a good arch form in two segments, from the maxillary right central incisor to second molar and from the maxillary left central incisor to second molar

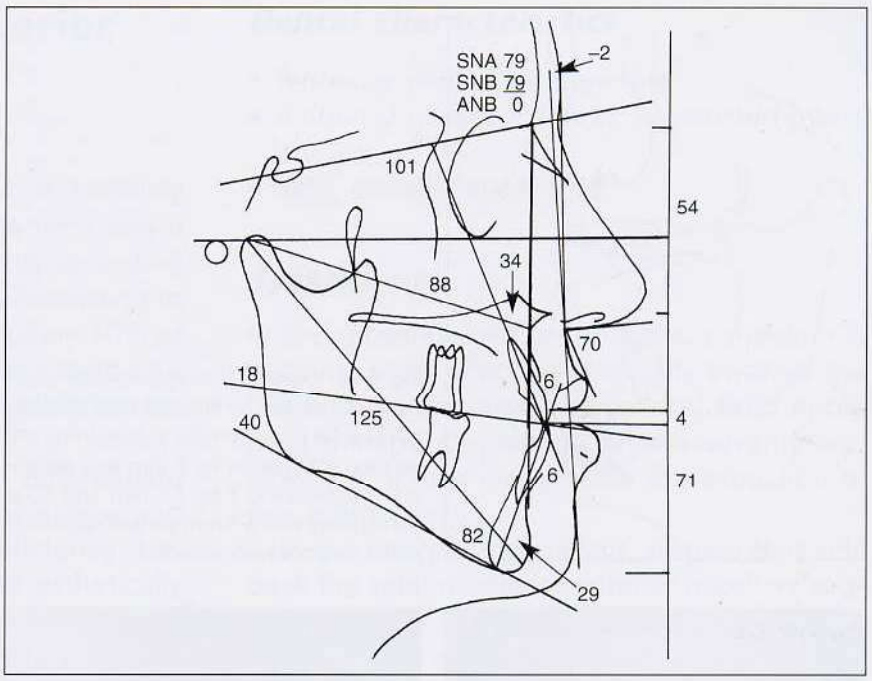


Fig 4-30 Case M.P. Cephalometric analysis. Class III dental relationship; Class III skeletal relationship; maxillary anteroposterior deficiency: SNA = 79 degrees, ratio of maxillary length to mandibular length = 88:125 mm; increased lower-third facial height: ratio of middle third to lower third = 54:71 mm; increased anterior mandibular height: height = 46 mm, ratio of upper lip to lower lip = 21:46; obtuse labiomental fold; lingually inclined mandibular incisors: mandibular incisor to mandibular plane, 82 degrees; acute nasolabial angle, 70 degrees; concave profile: facial contour angle = –2 degrees.

Fig 4-31 Case M.P. Presurgical frontal view *(a)*, profile view *(b)*, and occlusion *(c)*. Note the orthodontic correction of the dental midlines and the decompensation of the mandibular incisors.

- Expansion of the arch within the bony base
- Deviation of the roots of the central incisors

• Mandibular arch (see Fig 4-31)
- Extraction of both mandibular second premolars and removal of impacted third molars
- Establishment of a good arch form
- Decompensation of the incisors

Surgical treatment

- The maxilla was advanced and expanded by means of a two-piece Le Fort I maxillary osteotomy. The interdental osteotomy was performed between the maxillary central incisors. The maxilla was superiorly repositioned to improve the tooth-lip relationship (Fig 4-32).

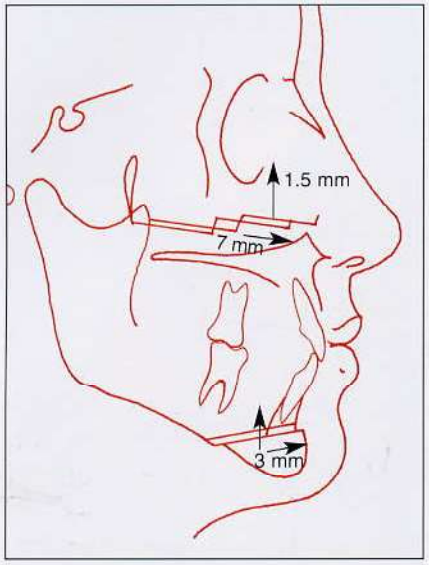


Fig 4-32 Case M.P. Surgical visual treatment objective. The surgical plan consists of *(1)* a Le Fort I maxillary osteotomy advancing the maxilla by 7 mm and superiorly repositioning it by 1.5 mm and *(2)* a genioplasty with a 3-mm vertical reduction and a 3-mm advancement.

Fig 4-33 Case M.P. Posttreatment results are demonstrated in frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

- Finally, genioplasty was performed to reduce the vertical height of the chin and advance the chin slightly (see Fig 4-32).

Postsurgical orthodontics

- Corrected the angulation of the maxillary incisors.
- Controlled the surgical expansion by placing a palatal bar as soon as possible after surgery.
- Refined the occlusion.
- Initiated orthodontic retention after debanding.

The surgery was performed after a 17-month presurgical period of orthodontics, and the orthodontic bands were removed 4 months after surgery. The treatment results 6 months after band removal are illustrated in Fig 4-33.

Maxillary Anteroposterior Excess

Maxillary anteroposterior excess is certainly not as common as was implied when Class II malocclusions were classified strictly according to the Angle dental classification. According to McNamara (1981), only approximately 10% of a group of 277 patients with Class I malocclusions had true maxillary anteroposterior excess.

The clinician should carefully differentiate between maxillary anteroposterior excess and mandibular anteroposterior deficiency because of the previously discussed esthetically unfavorable results achieved after the surgical or orthodontic retraction of maxillary incisors in a patient with mandibular anteroposterior deficiency. Of course, maxillary anteroposterior excess can occur in combination with mandibular deficiency (see Case O.M. later in this section).

Overview

Clinical characteristics

Profile view

- General protrusion of the middle third of the face
- Nose that often appears large and has a dorsal hump
- Prominent infraorbital rims and cheekbones
- Upper lip often short and everted
- Deep labiomental sulcus due to the fact that the lower lip curls under the maxillary incisors
- Lip incompetence
- Acute nasolabial angle

Frontal view

- Noticeable prominence of the middle third of the face
- Often, a long lower facial height
- Short, curled upper lip
- Curled lower lip under maxillary incisors

Dental characteristics

- Tendency toward an open bite
- Tendency toward a narrow, constricted maxillary arch
- High, arched palatal vault

Treatment

In the growing child, orthodontic correction is certainly most effective. It usually involves the use of headgear and multibanded fixed appliance therapy. Depending on the severity and crowding, it also may involve the extraction of four premolars.

In the nongrowing patient, surgery that sets back the total maxilla or anterior maxillary segment hastens treatment and avoids headgear therapy. Total maxillary setback is performed at the Le Fort I level and is technically difficult.

Surgical treatment

Three surgical techniques for repositioning the anterior maxilla have been described by Wassmund (1935), Cupar (1954), and Wunderer (1963). When posterior movement of the anterior maxillary segment is the main objective, the technique described by Wunderer is the most practical approach.

An anterior segmental osteotomy of the maxilla is often performed as part of a multisegment Le Fort I procedure because patients who need anterior maxillary correction often need additional corrections to the maxilla (eg, superior repositioning and/or expansion of the posterior maxilla). The author finds it easier to perform a multipiece Le Fort I procedure than an anterior segmental osteotomy.

In the presurgical phase, the roots of the teeth on either side of the osteotomy cut must be deviated sufficiently. Inadequate deviation of the roots of these teeth will:

1. Limit the surgical setback
2. Increase the risk of damage to the tooth roots at surgery
3. Force the surgeon to rotate the segment, thereby either elevating the canines out of occlusion or tipping the incisors inferiorly (Fig 4-34)

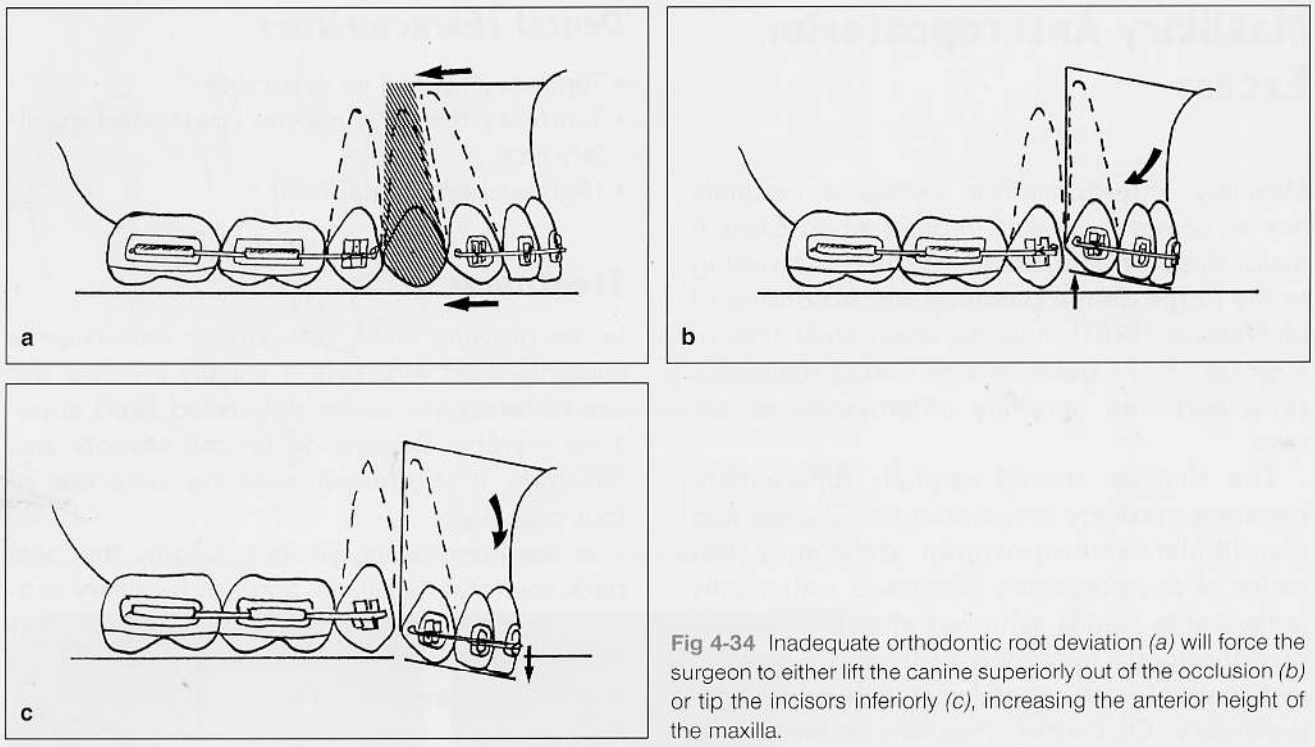


Fig 4-34 Inadequate orthodontic root deviation *(a)* will force the surgeon to either lift the canine superiorly out of the occlusion *(b)* or tip the incisors inferiorly *(c)*, increasing the anterior height of the maxilla.

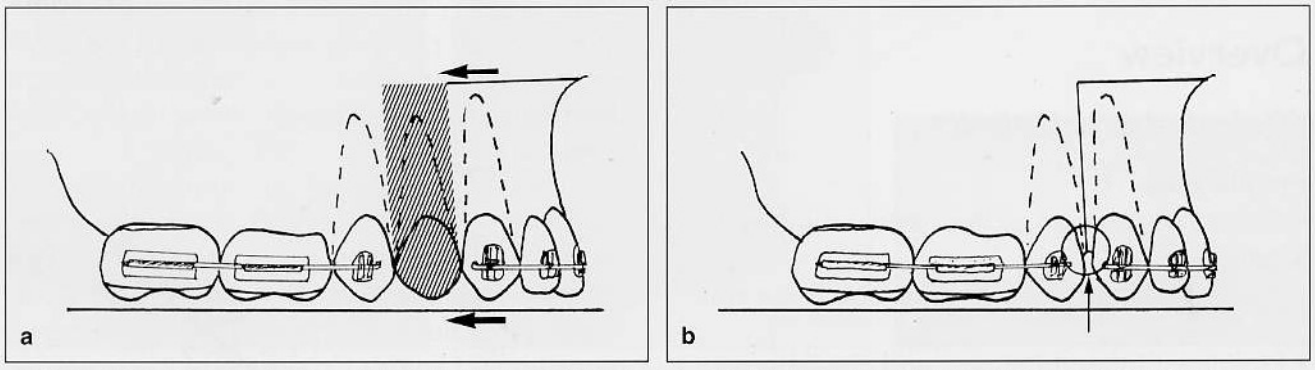


Fig 4-35 *(a)* Adequate orthodontic deviation of the roots of the teeth adjacent to the interdental osteotomy will allow the surgeon to close an interdental space. *(b)* To ensure the integrity of the periodontium, the space should never be completely closed, and a small amount of alveolar bone should always be left intact at the alveolar crest.

Adequate deviation of the roots allows setback of the anterior maxillary segment. A small area of interproximal bone should be maintained and the crowns of the teeth not forced together (Fig 4-35).

Maxillary setback procedures are seldom indicated. The clinician contemplating such a procedure should consider the esthetic effects carefully before making a final decision.

Fig 4-36 Case O.M. Pretreatment frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

Clinical cases

Case O.M.

The general practitioner referred this 32-year-old female patient to the orthodontist for the correction of her protruding teeth.

Main complaint

The patient was self-conscious about her prominent front teeth and inability to close her lips without strain.

Medical history

Her medical history was noncontributory.

Clinical examination

1. Soft tissue (Figs 4-36a to 4-36c)
   a. Frontal view
      - Increased interlabial gap
      - Increased maxillary incisor exposure
      - Everted lower lip
      - Chin that appears narrow
   b. Profile view
      - Convex profile
      - Increased interlabial gap
      - Protruding upper and lower lips
      - Deficient chin
2. Dental (Fig 4-36d)
   - Maxillary and mandibular dental protrusion
   - Class II malocclusion
   - Increased incisor overjet
   - Small area of attached gingiva in the mandibular incisor region
   - Gingival recession at the maxillary second premolars
3. Skeletal (Fig 4-37)
   - Vertical maxillary excess
   - Maxillary anteroposterior excess
   - Mandibular anteroposterior deficiency
   - Micrognenia
   - Narrow chin

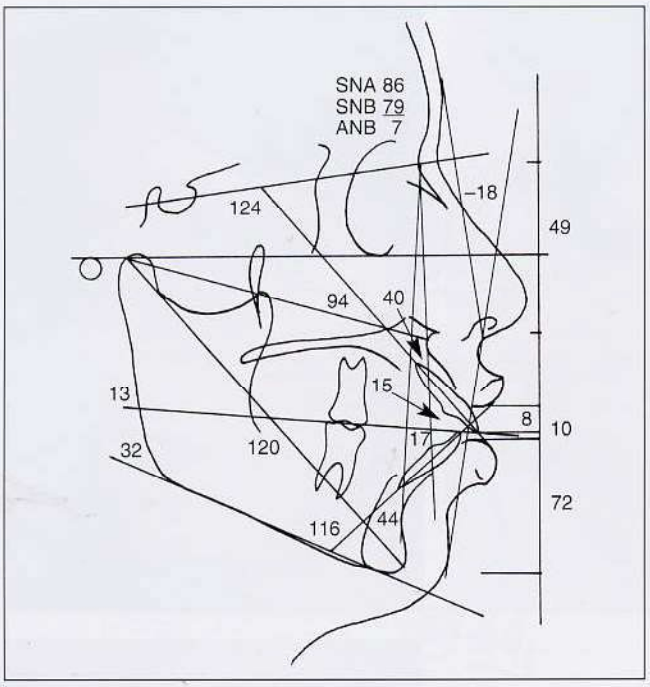


Fig 4-37 Case O.M. Pretreatment cephalometric analysis. Convex profile: facial contour angle = −18 degrees; increased interlabial gap: 10 mm; increased lower-third facial height: ratio of middle facial height to lower facial height = 49:72 mm; maxillary anteroposterior excess: SNA = 86 degrees; maxillary dental protrusion: maxillary incisor to S-N = 124 degrees, maxillary incisor to N-A = 15 mm and 40 degrees; mandibular dental protrusion: mandibular incisor to mandibular plane = 116 degrees, mandibular incisor to N-B = 17 mm and 44 degrees.

Fig 4-38 Case O.M. Frontal view *(a)*, profile view *(b)*, and right side of the occlusion *(c)* after completion of orthodontic preparation.

4. Radiographic
   a. Panoramic radiograph
      - Root treated at the maxillary left first molar
   b. Cephalometric (see Fig 4-37)
      - Confirms the clinical observations

Problem list

1. Bidental protrusion
2. Maxillary anteroposterior excess
3. Vertical maxillary excess
4. Mandibular anteroposterior deficiency
5. Microgenia
6. Class II malocclusion

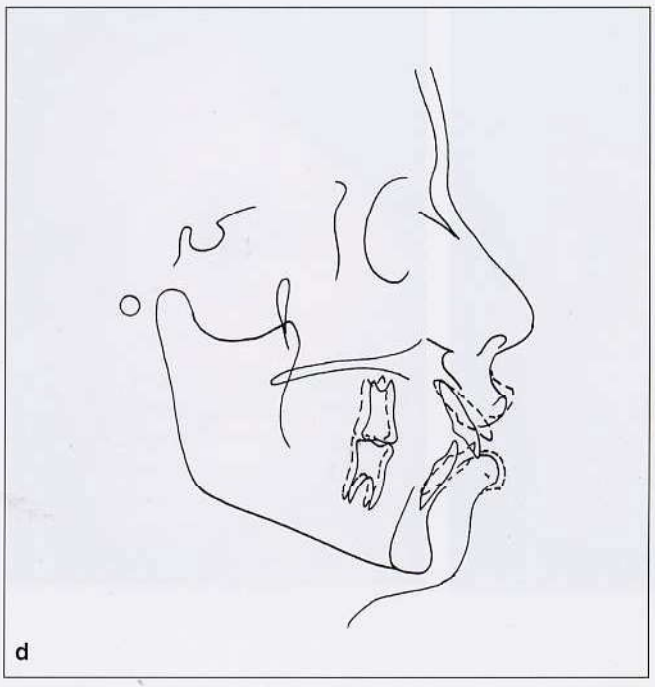


Fig 4-38 *Continued* Case O.M. The dental change after presurgical orthodontics is illustrated in *(d)*.

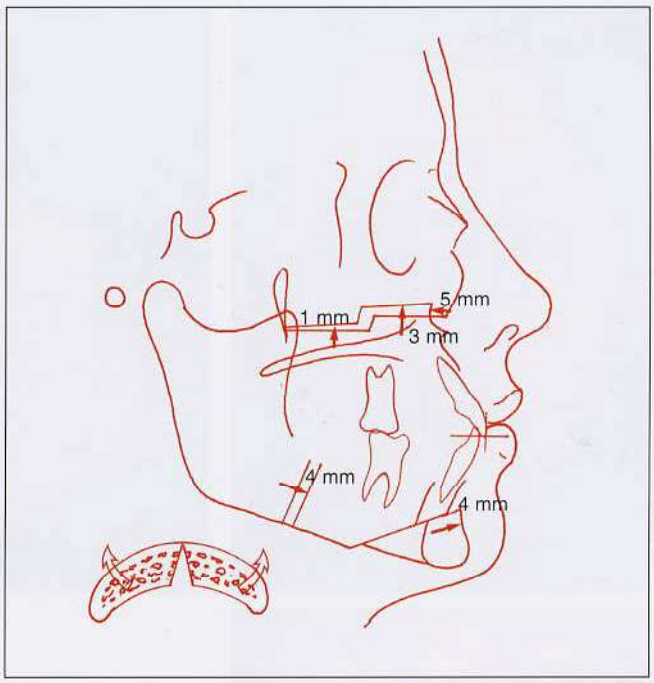


Fig 4-39 Case O.M. The surgical correction consisted of a Le Fort I osteotomy to superiorly reposition and set back the maxilla, bilateral sagittal split osteotomy to advance the mandible, and genioplasty to advance and widen the chin *(inset)*.

Presurgical orthodontics

- Maxillary arch (Figs 4-38a to 4-38d)
  - Extraction of both maxillary second premolars
  - Retraction of the incisors
  - Establishment of a good arch form
- Mandibular arch (Figs 4-38a to 4-38d)
  - Extraction of both mandibular first premolars
  - Retraction of the incisors
  - Leveling of the curve of Spee
  - Establishment of interarch compatibility

Surgical treatment

- Le Fort I maxillary osteotomy to superiorly reposition the maxilla with a setback (Fig 4-39)
- Bilateral sagittal split osteotomy to advance the mandible (see Fig 4-39)
- Genioplasty to simultaneously advance and widen the chin (see Fig 4-39)

Postsurgical orthodontics

Postsurgical orthodontic treatment completed the interdigitation of the teeth and also involved retention. The surgery was performed 24 months after the commencement of orthodontic treatment, and the orthodontic bands were removed 8 months after surgery. The treatment results are illustrated in Fig 4-40.

Case M.G.

Case M.G. illustrates the anteroposterior and vertical reduction of the maxilla by means of a segmental Le Fort I procedure (Figs 4-41 to 4-43).

Fig 4-40 Case O.M. Posttreatment results are demonstrated in frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

Fig 4-41 Case M.G. Pretreatment frontal view *(a)*, profile view *(b)*, smile *(c)*, and occlusion *(d)*.

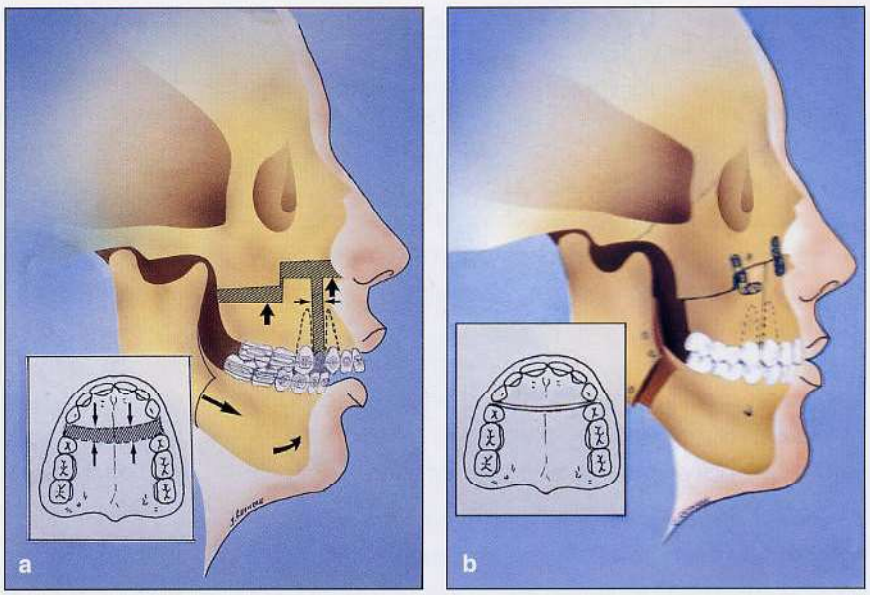


Fig 4-42 Case M.G. The maxillary first premolars were removed and the maxillary arch aligned in three segments. Excessive space was maintained *(a)* and surgically closed by posterior prepositioning of the anterior maxillary segments *(b)*. The maxilla was superiorly repositioned and the mandible advanced.

Fig 4-43 Case M.G. Posttreatment frontal view *(a)*, profile view *(b)*, smile *(c)*, and occlusion *(d)*. Note the correction of the maxillary midline.

Maxillary Vertical Deficiency

Maxillary vertical deficiency is very often associated with maxillary anteroposterior deficiency in which the maxilla did not develop in a forward and downward direction. It is common in patients with cleft lip and cleft palate, where early surgery often curtails normal development of the maxilla. Because overclosure of the mandible makes patients with maxillary vertical deficiency appear clinically similar to those with mandibular anteroposterior excess, the clinician should differentiate between the two deformities.

Overview

Clinical characteristics

Profile view

- The lower and middle thirds of the face are proportionally reduced in height when the patient's teeth are in occlusion.
- The nasolabial angle is acute.
- Overclosure causes the chin to appear excessive.
- The profile improves when the mandible is in the rest position.
- The maxillary incisors are not visible under the upper lip.

Frontal view

- The face appears short and square, with strong, exaggerated masseter muscles.
- The maxillary incisors are often not visible with the mouth open, creating an edentulous appearance, and the incisors are only partially exposed when the patient smiles.
- When the mandible is closed, the corners of the mouth are turned down, and skin folds are apparent lateral to the oral commissure.
- Nasal base may be broad and the nostrils large.
- The mandible appears excessive.

Dental characteristics

- The heavy musculature and overclosed occlusion frequently predispose the patient to bruxism and resulting attrition.
- Interocclusal freeway space is often increased.
- There is a Class III dental relationship.

Treatment

The surgical treatment objective in cases of maxillary vertical deficiency is to reposition the maxilla forward and downward. The mandible will rotate clockwise, and the vertical height of the face will increase. Patients with maxillary vertical deficiency invariably have an increased interocclusal freeway space, which should be carefully evaluated. The increase in vertical height achieved by downgrafting the maxilla should be less than the "available" interocclusal freeway space.

The extent of the vertical deficiency can be measured only with the patient's lips in repose and almost touching. Pretreatment cephalometric radiographs should be taken with the mandible in the rest position and the lips barely touching. This can be facilitated by the use of a wax splint. The cephalometric visual treatment objective should be created on a radiograph taken with the mandible rotated open and the lips barely apart. This radiograph will give the surgeon a good indication of *(1)* the required amount of maxillary downgrafting to achieve an ideal lip-tooth relationship and *(2)* the mandibular anteroposterior position following clockwise rotation.

Presurgical orthodontics

The objective in presurgical orthodontic treatment in maxillary vertical deficiency cases is to *(1)* level and align the teeth and *(2)* coordinate the arches. Significant anteroposterior compensations are seldom present, and the incisors can often be left in their original anteroposterior positions. If severe crowding is present, the maxillary and mandibular first premolars are extracted; with mild crowding, the maxillary and mandibular second premolars are extracted. Where larger maxillary advancement is needed in cases with crowding, the first maxillary premolars and second mandibular premolars are extracted to create a large crossbite.

If a transverse deficiency of the maxilla is present, it is best to correct it surgically. The maxillary arch can often be coordinated in two halves to "fit" the mandibular arch and the archwire cut in the center. A stabilizing palatal arch should be placed as soon as possible

after surgery, and it should be anticipated presurgically.

Surgical treatment

The maxilla can be repositioned inferiorly by a Le Fort I downgrafting procedure. This procedure was unstable in the past, and as high as a 70% loss of vertical height has been reported. However, rigid fixation has substantially improved the stability of the procedure.

Definitive presurgical planning of the exact amount of maxillary inferior repositioning is critical. The clinician should be guided by both the amount of interocclusal rest space and the maxillary incisor–upper lip relationship.

After the maxilla is mobilized on the Le Fort I level, intermaxillary fixation is placed. The condyles are seated in the glenoid fossae, and with gentle backward and upward pressure at the mandibular angles, the maxilla is rotated closed until the desired, preplanned interosseous distance is achieved. Four bone plates—two at the zygomatic buttresses and two at the piriform rims—are placed.

An interpositioning graft is then placed (or it may be placed before the bone plates). This graft is shaped to fit snugly into the bony defect to prevent displacement into the maxillary sinus. If the transverse dimension of the maxilla is increased by surgical expansion, an acrylic occlusal splint is placed and the palatal bone defect grafted. An interdental wire is inserted between the teeth adjacent to the interdental osteotomy.

Patients with a combination of vertical and anteroposterior deficiency may be candidates for the Le Fort I downsliding osteotomy design. The surgical plan for these patients should include maxillary advancement in addition to correction of the vertical discrepancy. In these cases, the osteotomy is angled to provide an inclined plane that will increase the vertical dimension as the maxilla slides forward. The horizontal length from the piriform rim to the lateral aspect of the zygoma is measured on a lateral cephalogram. This measurement is used to calculate the downward angulation of the osteotomy and the position of the vertical steps.

Postsurgical orthodontics

At the first postsurgical visit, the orthodontist checks the occlusion and instructs the patient to wear appropriate elastics. If surgical expansion of the maxillary arch was performed, the orthodontist should do the following:

1. Remove the sectional archwire and replace it with a continuous archwire.
2. Place a palatal arch that is carefully adapted to the lingual surface of all teeth distal to the canines.

At first, the orthodontist sees the patient once every 1 to 2 weeks for routine adjustment of archwires and elastics. With good progress, the patient goes to a 4-week adjustment schedule, and postsurgical orthodontic treatment is concluded as previously discussed.

Clinical case

Case B.E.

This 15-year-old female patient was referred by her practitioner for the correction of a Class III malocclusion.

Main complaint

The patient's main complaint was that she was unable to bite anything with her front teeth and that her face appeared too flat.

Medical history

The patient's medical history was noncontributory.

Clinical examination

1. Soft tissue
   a. Frontal view (Figs 4-44a and 4-44b)
      - Paranasal flattening
      - Lack of upper lip support
      - Maxillary incisors barely visible when the patient's lips are apart
      - Mandible that appears large
   b. Profile view (Fig 4-44c)
      - Concave profile
      - Upper lip that appears flat
      - Mandible that appears to be strong and overclosed

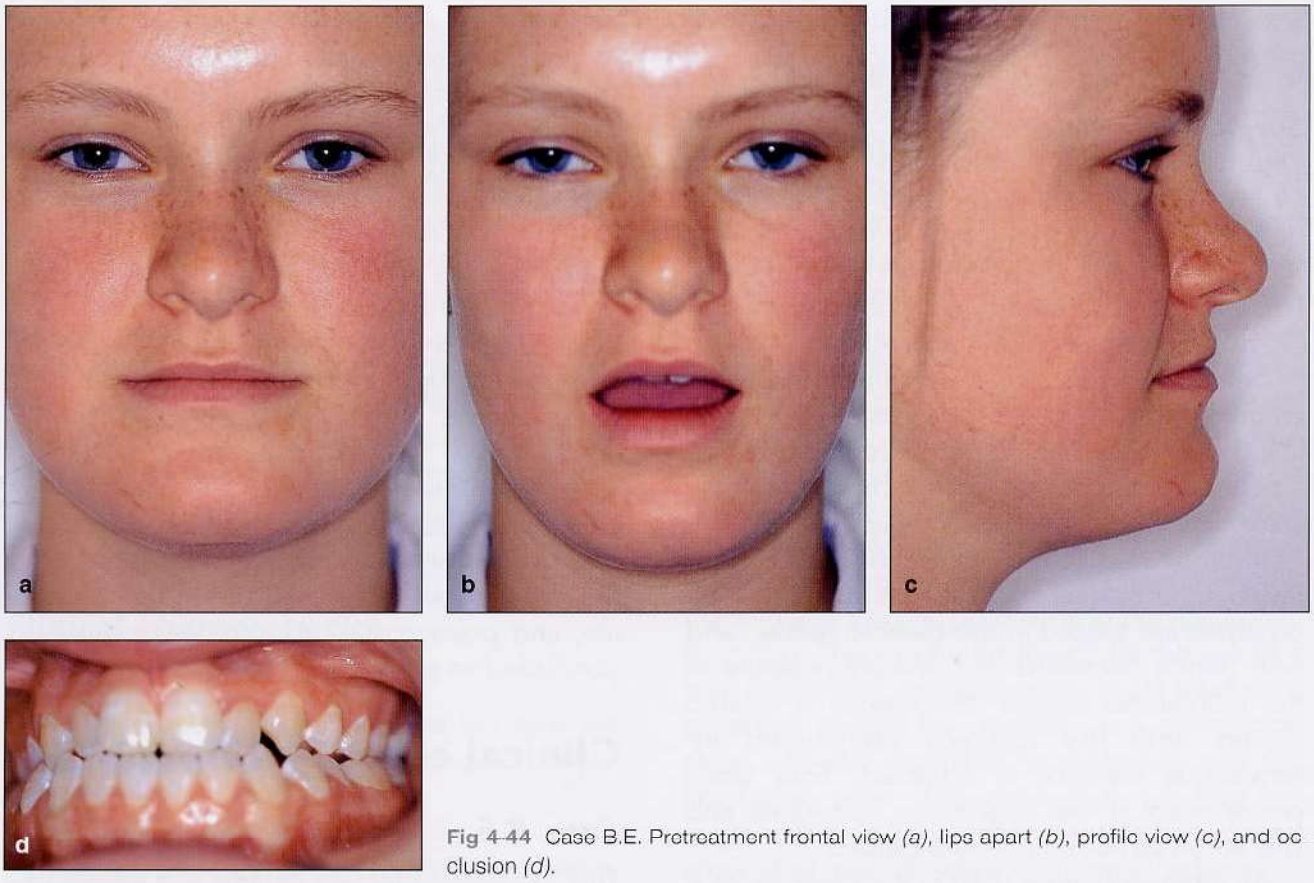


Fig 4-44 Case B.E. Pretreatment frontal view *(a)*, lips apart *(b)*, profile view *(c)*, and occlusion *(d)*.

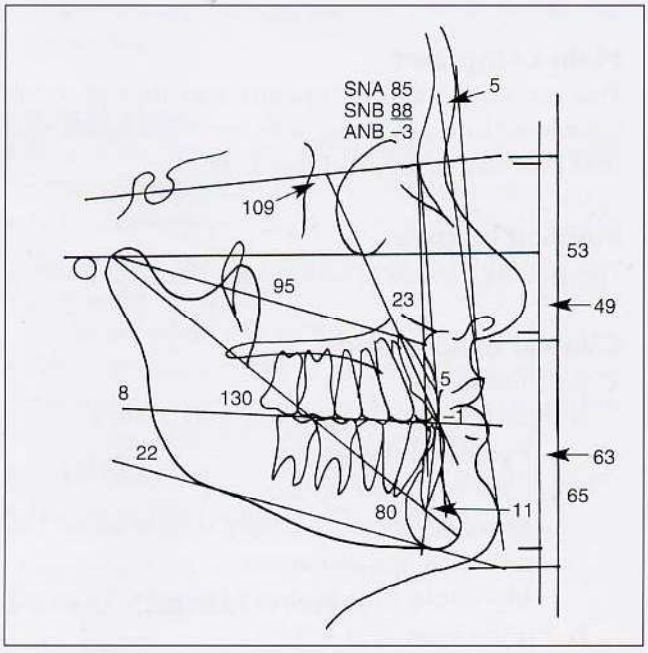


Fig 4-45 Case B.E. Pretreatment cephalometric analysis. Class III malocclusion; maxillary anteroposterior deficiency; Class III skeletal relationship: ANB = –3 degrees; mandibular incisor compensation: mandibular incisor to mandibular plane = 80 degrees, mandibular incisor to N-B = 11 degrees; concave profile: facial contour angle = 5 degrees.

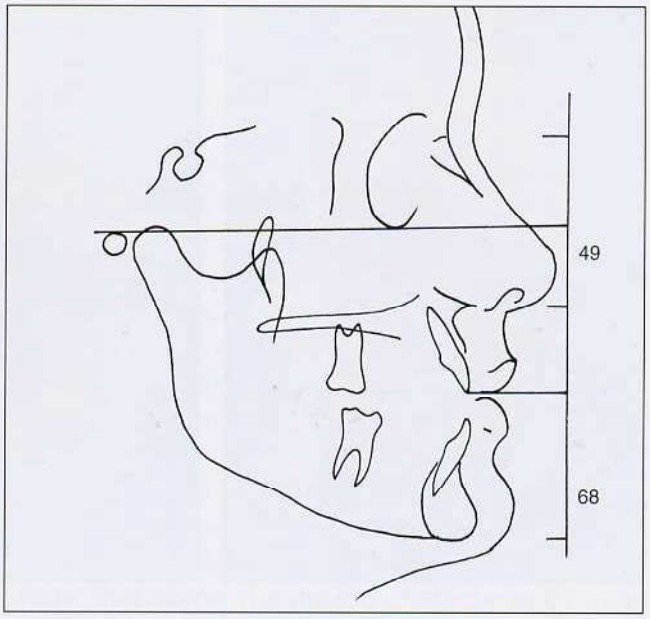


Fig 4-46 Case B.E. Tracing of a pretreatment cephalometric radiograph taken with the patient's mandible rotated clockwise until the lips just part. Note the maxillary incisor–lip relationship. The final vertical position of the maxilla is planned from this tracing.

Fig 4-47 Case B.E. Immediate presurgical occlusion.

2. Dental (Fig 4-44d)
   - Edge-to-edge incisor relationship with an open bite tendency
   - Class III malocclusion
   - Narrow maxillary arch
   - Tendency to posterior crossbites
   - Compensated mandibular incisors
3. Skeletal (Figs 4-45 and 4-46)
   - Anteroposterior maxillary deficiency
   - Vertical maxillary deficiency
4. Radiographic (see Figs 4-45 and 4-46)
   a. Cephalometric
   - Confirms the clinical diagnosis of a Class III malocclusion with vertical and anteroposterior maxillary deficiency

Problem list

1. Vertical maxillary deficiency
2. Anteroposterior maxillary deficiency
3. Class III malocclusion
4. Anterior open bite
5. Narrow maxillary arch

Presurgical orthodontics

- Maxillary arch (Fig 4-47)
  - Alignment of the arch
  - Expansion of the posterior teeth within the bony limits
- Mandibular arch (see Fig 4-47)
  - Decompensation of the incisors
  - Establishment of interarch compatibility

Surgical treatment

Surgical treatment involved a Le Fort downsliding osteotomy. The osteotomy is performed at a predetermined angle so that the maxilla will slide downward as it is advanced, thus increasing the vertical height while bone contact is maintained (Fig 4-48).

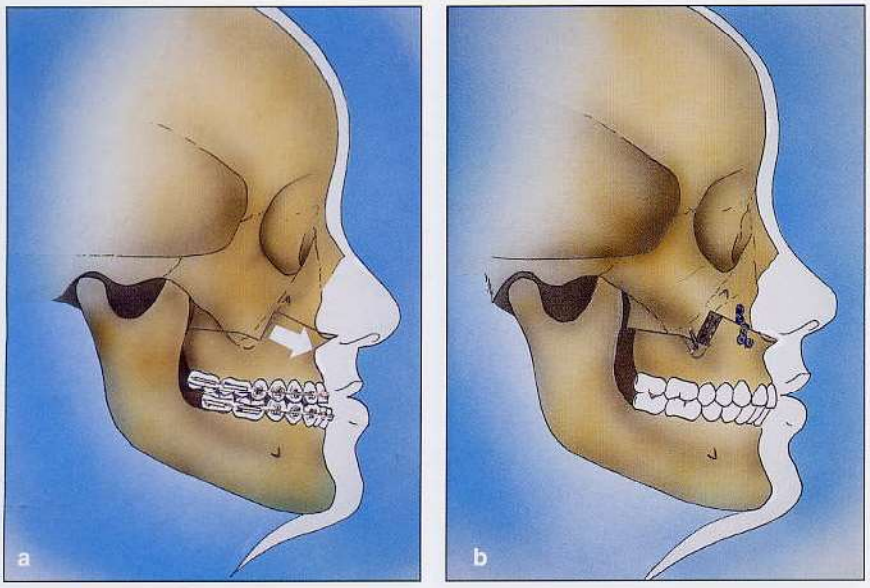


Fig 4-48 Case B.E. *(a)* Surgical plan illustrating the angled Le Fort I osteotomy. *(b)* As the maxilla is advanced, it will slide downward, increasing the vertical height.

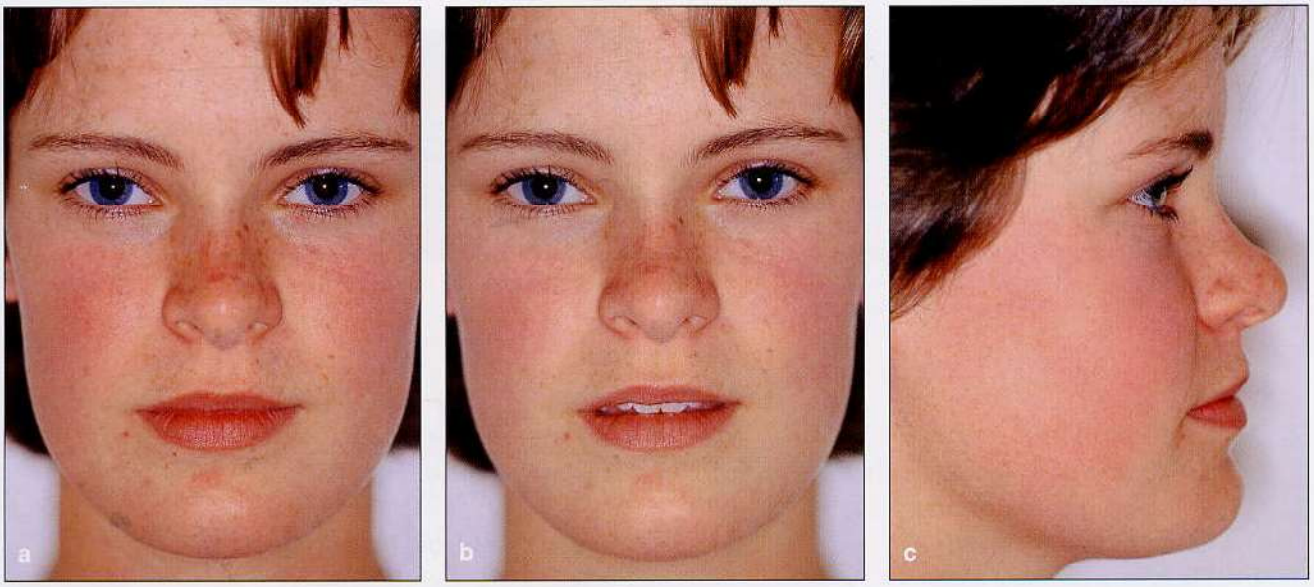


Fig 4-49 Case B.E. Posttreatment results are demonstrated in frontal view *(a)*, lips apart *(b)*, profile view *(c)*, and occlusion *(d)*.

Postsurgical orthodontics

The postsurgical orthodontic treatment finalized the occlusion and advanced to the retention stage. The orthodontic preparation before surgery took 6 months, and the bands were removed 4 months after surgery. Figure 4-49 illustrates the posttreatment results 7 months after surgery.

Maxillary Vertical Excess

Approximately 30% of patients seeking treatment have a vertical increase in the lower third of the face. In our experience, the main complaints of patients with vertical maxillary excess are a gummy smile and/or functional problems due to the anterior open bite, the hallmarks of the long face deformity.

Overview

Clinical characteristics

Profile view

- Increased total facial height due to an increased lower facial height
- Mandible rotated downward and backward
- Increased interlabial distance (greater than 4 mm)
- Increased maxillary incisor exposure (except in some open bite cases)
- Sunken cheeks
- Often, a well-developed, almost excessive, curled lower lip

Frontal view

- Narrow alar base width
- Excessive maxillary incisor exposure (except in some open bite cases)
- Increased interlabial distance
- Often, increased vermillion exposure of the lower lip
- Increased lower-third facial height
- Gummy smile
- Depressed paranasal areas with a tendency to flat cheeks

Dental characteristics

- Often, an anterior bite
- High, arched palate with a large distance between the root apexes and the nasal floor
- V-shaped maxilla and teeth often in palatal crossbite
- Mandibular incisors that tend to become more upright and therefore more crowded

Because of the excessive vertical growth of the maxilla, the mandible tends to rotate downward and backward. These patients, therefore, often also have problems in the anteroposterior plane. Patients with long faces can be described as being skeletal Class I rotated to Class II or as Class III rotated to Class I. It can be concluded that excessive vertical growth of the maxilla will make mandibular anteroposterior deficiencies appear worse and mandibular anteroposterior excesses appear better. Frequently there is an accentuated curve of Spee due to overeruption of mandibular incisors, especially in cases without open bites.

There is a tendency for anterior open bites in two thirds of these patients. The clinician should note that some diagnostic characteristics may be camouflaged in patients with vertical maxillary excess and deep bites (Fig 4-50). First, because of the deep bite, the lower facial height may not be increased. Second, the maxillary incisors may be excessively exposed under the upper lip; however, this exposure is covered by the lower lip.

The combination of three main characteristics may be considered diagnostic for vertical maxillary excess:

1. Increased mandibular plane angle
2. Increased total anterior facial height
3. Decreased percentage contribution of upper facial height to total facial height

Treatment

The two most important rules in the treatment of vertical maxillary excess follow:

1. Never treat the smile.
2. Always plan the treatment with the lips in repose.

There is no alternative to surgery for adult patients with vertical maxillary excess. Attempts to close the open bite by orthodontic extrusion of anterior teeth or intrusion of posterior teeth are not a solution, for two reasons: *(1)* relapse into open bite almost always occurs, and *(2)* extrusion of the maxillary incisors will worsen the esthetics.

Fig 4-50 Frontal view *(a)* and profile view *(b)* of a patient with a severe Class II deep bite *(c)*. The vertical height of the maxilla cannot be assessed because of the over-closed bite. The vertical excess (excessive tooth exposure under the upper lip) is evident *(d and e)* when the mandible is rotated into the correct interincisal overbite. Note the gummy smile *(f)*. Vertical excess (disguised by the deep bite) is demonstrated on the cephalometric tracing *(g)*.

Presurgical orthodontics

As in all surgical orthodontic cases, the approach is to align the teeth presurgically to facilitate the planned surgery so that the teeth will fit into occlusion after surgery:

1. It is preferable to level the mandibular arch before surgery (in contrast to the approach in patients with short faces).
2. Patients with vertical maxillary excess and severe open bites often have an excessive reverse curve in the maxillary arch. In these cases it is advantageous to level the arch in segments and deviate the roots of teeth to allow interdental osteotomies. Therefore, level within the segments. Do not attempt to close the open bite; rather, open the bite further.
3. A similar principle applies in the decision to expand a narrow maxilla orthodontically. The teeth should not be expanded beyond their bony base. Any relapse of an expanded maxillary arch will tend to open the bite anteriorly. Surgical expansion is recommended, especially in more severely narrowed maxillae and in older patients.

Orthodontic mechanics

- Mandibular arch
  - Routine orthodontic techniques are used to level, align, close all spaces, and achieve a good arch form.
  - Extractions and Class II or Class III mechanics may be necessary, depending on the case.
- Maxillary arch
  - Teeth adjacent to the proposed interdental osteotomies (eg, between maxillary canines and premolars or between maxillary lateral incisors and canines) are bonded with brackets that will "diverge" the roots away from the surgical site to prevent accidental surgical insult to the roots. For example, a maxillary left canine bracket is placed on the right canine and vice versa. This still applies if premolars are removed to provide crowding relief. After surgery is completed, these brackets are removed and the correct brackets bonded to obtain normal root inclination.
  - Leveling is accomplished using sectional nickel-titanium alloy (Nitinol) wires or similar wires. Stabilization is then undertaken with sectional finishing archwires bent to conform to the arch form for each segment.
  - Extraction spaces can be closed by surgically approximating the segments.
  - If no vertical segmental discrepancies exist, the maxillary arch is leveled with a continuous archwire, taking care that the maxillary incisors do not level forward; nightly headgear use may be required. The maxillary and mandibular arches are coordinated with the aid of study casts.
  - Intrusive posterior mechanics, such as palatal bars or high-pull headgear, should be avoided.
  - Mandibular molars should be brought upright to encourage bite opening. This will accentuate the vertical problem and introduce less chance of relapse.

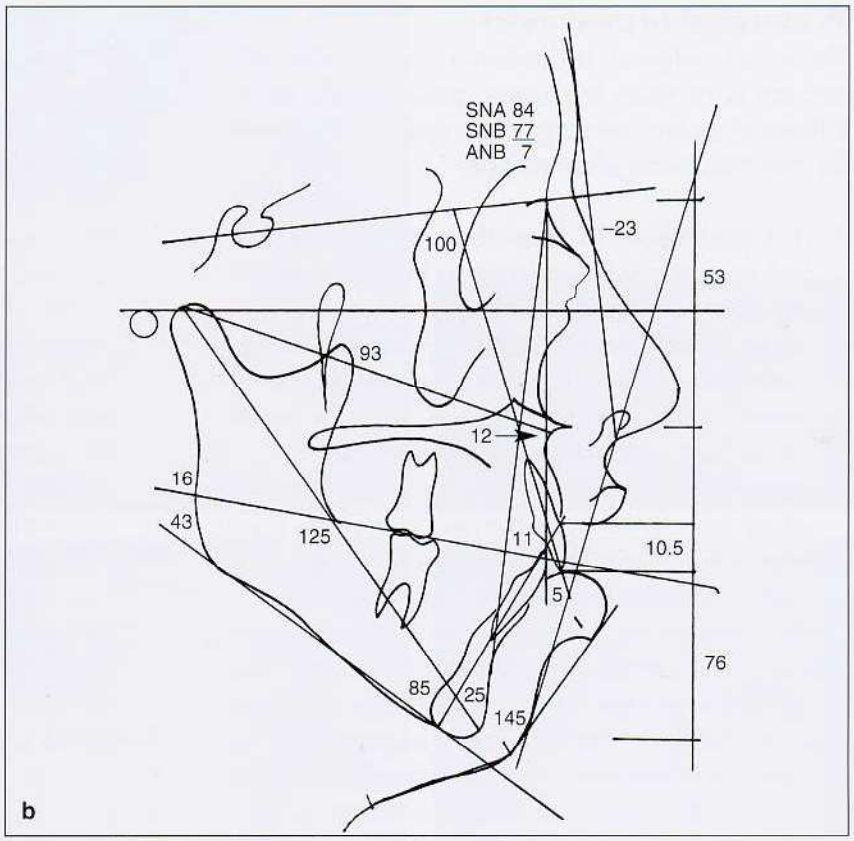
Surgical treatment

To correct the vertical discrepancy, the maxilla must be superiorly repositioned by a Le Fort I osteotomy. Two critical elements must be considered in the final treatment planning:

1. How far must the maxilla be superiorly repositioned?
2. After straight vertical repositioning of the maxilla, where will the mandible be?

Extent of superior repositioning The amount of superior repositioning is critical, because moving the maxilla too far superiorly is more detrimental to facial esthetics than leaving the vertical excess uncorrected. Consider the following points when planning superior repositioning of the maxilla:

1. Patients with short upper lips show more teeth than patients with long upper lips.
2. Younger patients tolerate (esthetically and psychologically) more upward movement of the maxilla than do older patients. Remember that the upper lip will lengthen with age.
3. Exposure of 30% to 40% of the clinical crowns of the maxillary incisors beneath the upper lip is esthetically pleasing.
4. During superior repositioning of the maxilla, the upper lip will shorten.



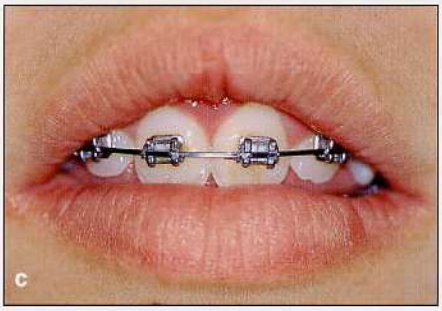


Fig 4-51 Assessment from a profile view *(a)* and a lateral cephalometric tracing *(b)* reveals an interlabial distance of 10 mm, requiring superior repositioning of the maxilla. If only this view is considered, superior repositioning of at least 6 mm is indicated. *(c)* Because of an accentuated Cupid's bow of the upper lip, the central incisors' entire crowns are exposed under the upper lip, while the lateral incisors are exposed much less. If planning of superior repositioning of the maxilla considers only the central incisor exposure, excessive superior repositioning will result in only the tips of the central incisors being visible under the upper lip.

5. Plan, in general, for a 4-mm tooth exposure after surgery.
6. It is not mandatory to elevate the maxilla until the lips make contact. A few millimeters of lip incompetence is acceptable and, in many cases, attractive.
7. Large movements, if not controlled, may lead to widening of the alar base of the nose and tipping up of the nasal tip. Because both effects are controllable, take them into consideration in treatment planning and surgical technique.
8. Moving the maxilla too far superiorly gives poor esthetic results, but moving it posteriorly at the same time yields even worse results.
9. Consider the upper lip shape. Patients with an extreme Cupid's bow may only have excessive exposure of the two central incisors. If surgery is planned using the lateral cephalometric radiograph without considering the lip shape, treatment may result in only the tips of the two central incisors being visible under the upper lip (Fig 4-51).

Anteroposterior position of the mandible The mandible will autorotate counterclockwise around a point at the condyle. As a consequence, the mandibular incisors will rotate forward (more so in high-angle cases than in low-angle cases). When the extent of maxillary superior repositioning has been decided, the anteroposterior position of the mandibular incisor should be considered. It may be necessary to advance the maxilla slightly to achieve a Class I malocclusion. If the mandible is anteroposteriorly deficient, a maxillary setback may be considered to achieve a Class I malocclusion; however, advancing the mandible is preferable. It is much better to accept the need for two-jaw surgery to achieve a good occlusion than to significantly compromise the esthetics and limit the surgery to one jaw. In Class III cases, the Class III dental relationship will worsen as the mandible is autorotated, necessitating either maxillary advancement or mandibular setback.

Important surgical considerations The amount of superior repositioning of the maxilla is critical. Take great care during surgery to accurately position the maxilla in the planned position. An intermediate splint is helpful.

Condyle positioning, again, is critical. The condyle can be displaced by minor bony interferences in the posterior maxilla. With maxillomandibular fixation, this condylar displacement will not be revealed until 6 weeks after surgery, after removal of maxillomandibular fixation. With rigid internal fixation, the malpositioning can be detected after intraoperative removal of maxillomandibular fixation and can be corrected by the removal of bone plates and the elimination of posterior interferences (see the section on intraoperative diagnosis of condylar sag during Le Fort I maxillary osteotomy in chapter 5).

It is often necessary to surgically expand the posterior maxilla through parasagittal osteotomies in the palate. A bone graft or hydroxyapatite blocks should be grafted into the defect and the segments stabilized by a splint with a palatal bar. Grafting should be used for any expansions greater than 3 mm.

The piriform rim should be contoured to accommodate the soft tissue of the nose.

The bony and cartilaginous septum should be shortened appropriately to prevent warping of the nasal septum during superior repositioning of the maxilla. To centralize the septum, a septum suture may be used to attach the septal cartilage to the base of the nasal spine as it passes through a hole in the nasal spine.

Wound closure should be meticulous. A cinch suture can control the alar base width, and V-Y closure can create lip lengthening or control the length of the upper lip. Resuture the perioral muscles, and then carefully suture the mucosa, taking thin bites. Be sure to maintain the soft tissue midline when suturing.

Postsurgical orthodontics

If a splint is used during surgery, the orthodontist should see the patient immediately after its removal. Stabilizing archwires are removed and replaced with working archwires, and light (2.5- to 3.5-oz) vertical or slightly Class II elastics are placed.

After surgical expansion, the most important, and possibly the most challenging, part of postsurgical orthodontics is to maintain the transverse dimension of the palate. The expanded dentoalveolar segments must be held in their expanded position during orthodontic finishing. This can be accomplished using either a heavy auxiliary wire in the headgear tubes, along with working wires, or a transpalatal arch (the latter may be more practical). The dentoalveolar segments do not stabilize until 4 to 6 months after surgery. In general, the postsurgical orthodontic treatment of patients with long faces is often quick because the arches were leveled either before or during surgery.

Clinical case

Case J.S.

The mother of this 16-year-old patient was treated by the author 10 years previously for the correction of vertical maxillary excess and mandibular deficiency. The patient was now referred for surgical correction of the same problem.

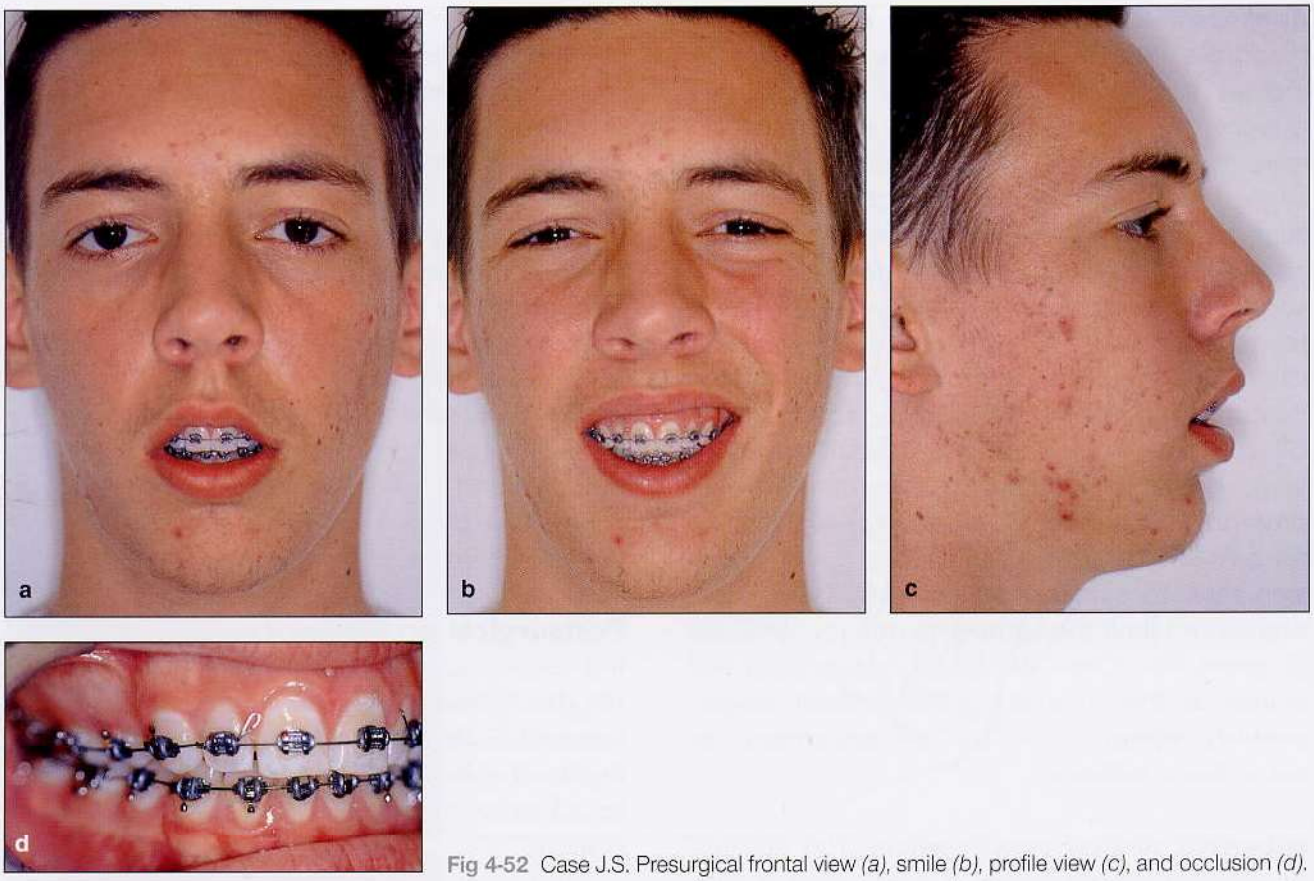


Fig 4-52 Case J.S. Presurgical frontal view *(a)*, smile *(b)*, profile view *(c)*, and occlusion *(d)*.

Main complaint

The patient was unhappy about his gummy smile and inability to create a lip seal without strain.

Medical history

The patient's medical history was noncontributory.

Clinical examination

1. Soft tissue
   a. Frontal view (Figs 4-52a and 4-52b)
      - Gummy smile
      - Increased interlabial gap
      - Excessive maxillary incisor exposure under the upper lip
      - Increased lower-third facial height
      - Increased lower lip vermillion exposure
   b. Profile view (Fig 4-52c)
      - Convex profile
      - Deficient chin
      - Prominent lower lip
      - Increased lower-third facial height
      - Increased tooth exposure
      - Increased interlabial gap
2. Dental (Fig 4-52d)
      - Class II malocclusion
      - Missing first premolars
3. Skeletal
      - Vertical maxillary excess
      - Mandible rotated clockwise and relatively deficient
      - Microgenia

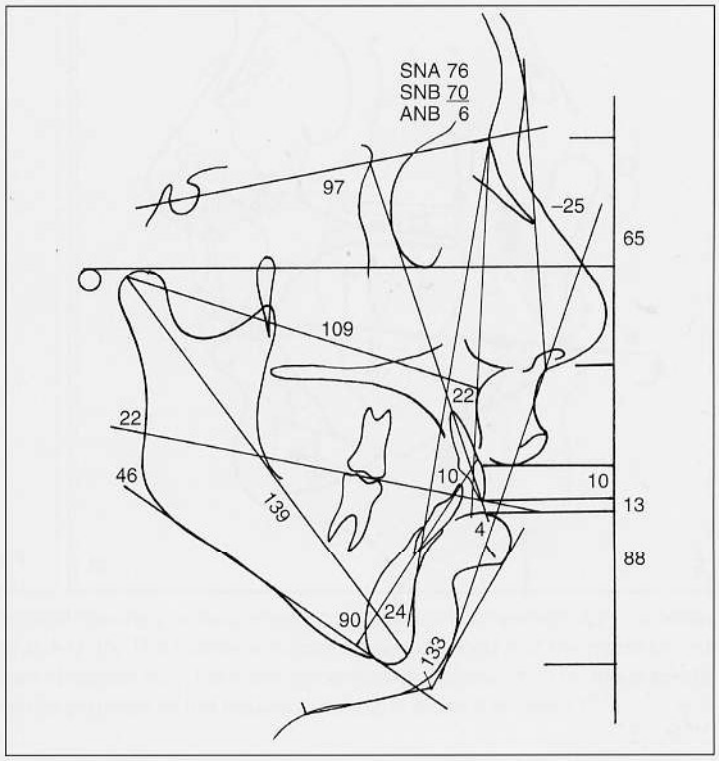


Fig 4-53 Case J.S. Presurgical cephalometric analysis. Vertical maxillary excess: interlabial gap = 13 mm, maxillary incisor tooth exposure = 10 mm, ratio of middle-third to lower-third height = 65:88 mm; convex profile: facial contour angle = −25 degrees; normal maxillary and mandibular length relationship: 109:139 mm.

4. Radiographic
   a. Panoramic radiograph
      - Missing first premolars
   b. Cephalometric radiograph (Fig 4-53)
      - Confirms clinical observations

Problem list

1. Vertical maxillary excess
2. Microgenia
3. Class II malocclusion

Presurgical orthodontics

The presurgical orthodontic treatment was completed by the time of the final referral.

Surgical treatment

- Le Fort I maxillary osteotomy to reposition the maxilla superiorly (Fig 4-54)
- Mandible autorotated counterclockwise into a Class I dental relationship (see Fig 4-54)
- Advancement genioplasty (see Fig 4-54)

Postsurgical orthodontics

Postsurgical orthodontic treatment involved completing the interdigitation of the teeth and retention. The pleasing postsurgical result is demonstrated in Fig 4-55.

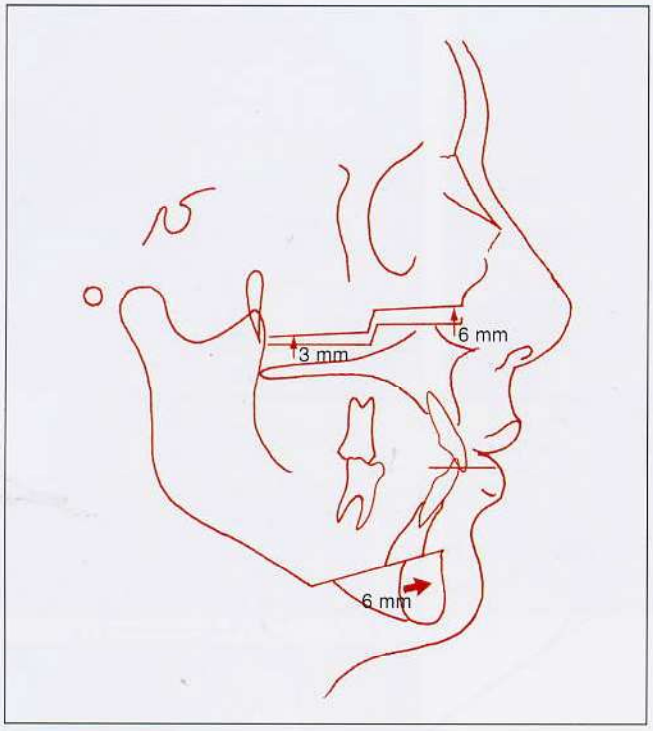


Fig 4-54 Case J.S. Surgical cephalometric visual treatment objective.

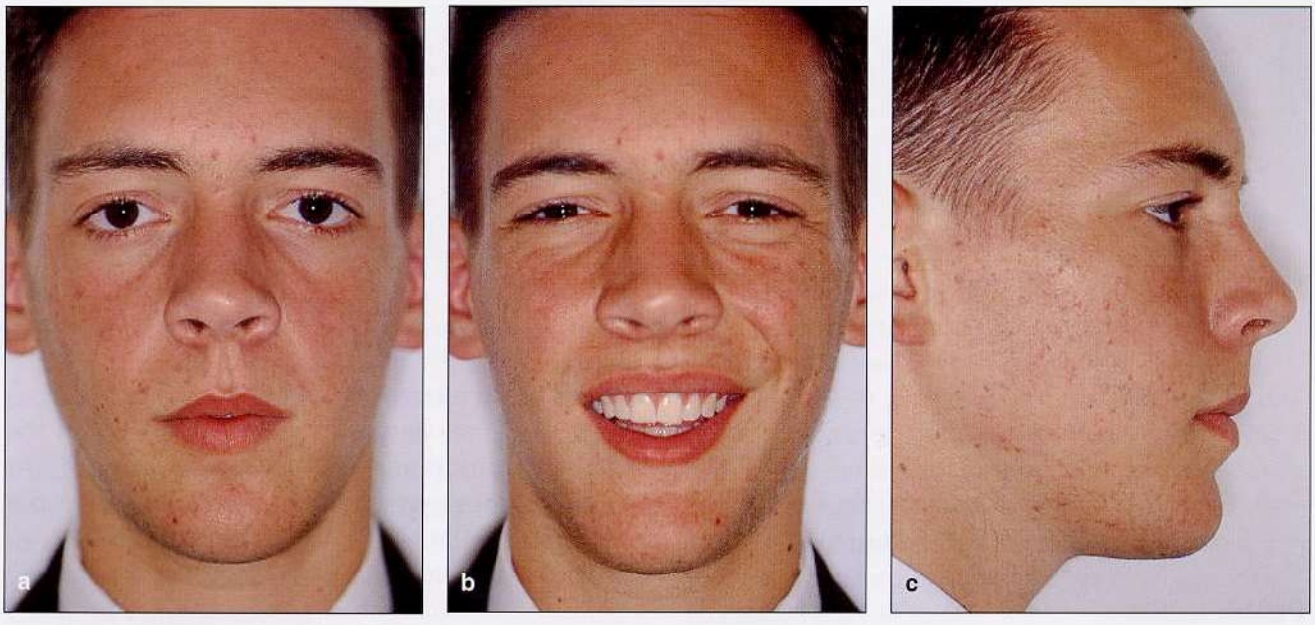


Fig 4-55 Case J.S. Postsurgical frontal view *(a)*, smile *(b)*, profile view *(c)*, and occlusion *(d)*.

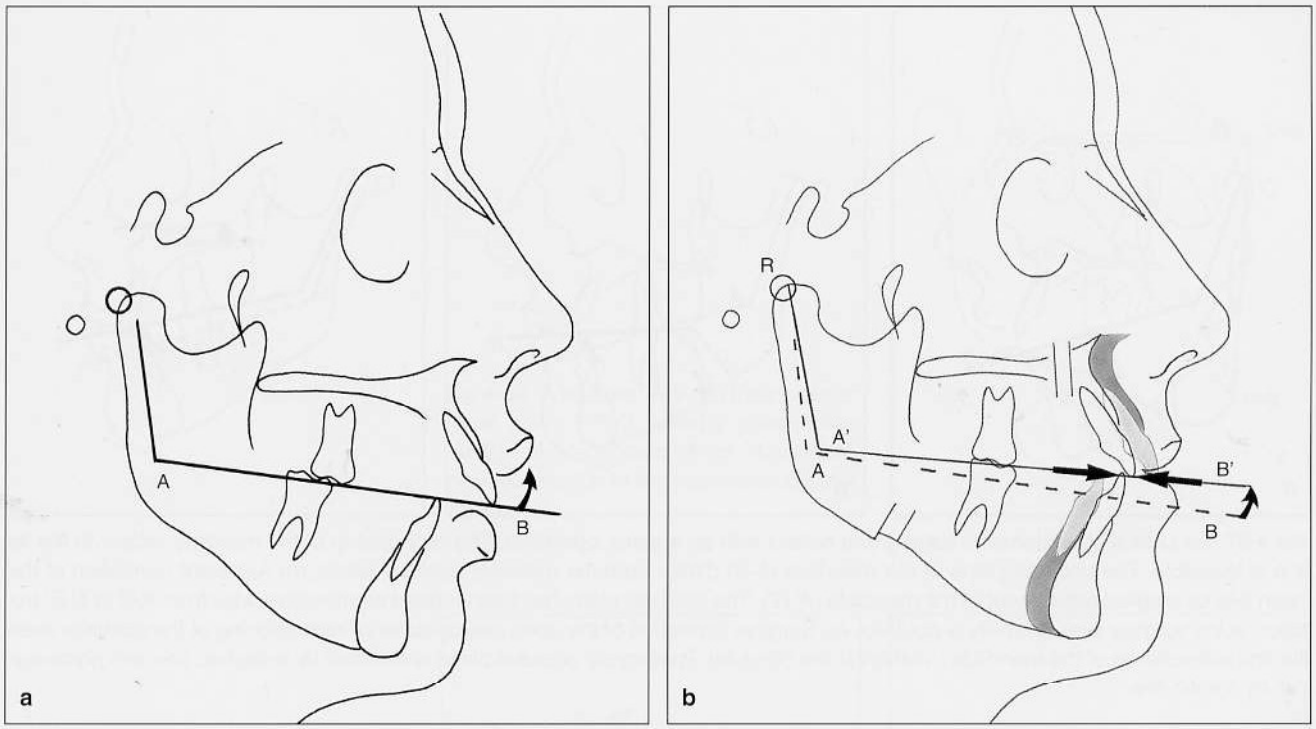


Fig 4-56 *(a)* Lateral cephalometric tracing of a patient with vertical maxillary excess, maxillary anteroposterior excess, and mandibular anteroposterior deficiency. The presurgical occlusal plane is A-B. *(b)* The maxilla is superiorly repositioned and the mandible autorotated around R. The "new" occlusal plane (A'-B') has been changed from the presurgical occlusal plane (A-B) by the autorotation of the mandible. The mandible is advanced, and the anterior segment of the maxilla is set back along this plane.

Rotation of the Maxillomandibular Complex

Most dentofacial deformities can be treated successfully using conventional treatment planning. With conventional treatment planning, alteration of the occlusal plane is often an inevitable consequence of any surgical adjustment to the vertical position of the maxilla and the resultant autorotation of the mandible (Fig 4-56a). This rotation of the mandibular occlusal plane occurs around a point at or just behind the head of the condyle. To achieve occlusal contact in these cases, the maxilla must be aligned along a "new" occlusal plane, which is determined by the extent of the autorotation of the mandible. Hence, it is the position assumed by the mandible that dictates the final anteroposterior cant of the occlusal plane. Any anteroposterior repositioning of the maxilla or mandible must take place along this "new" occlusal plane (Fig 4-56b).

Any counterclockwise rotation of the distal segment around a point beyond the condyle (at the surgical site) of the mandible may jeopardize posttreatment stability (Figs 4-57a and 4-57b). A more stable result can be achieved by superior repositioning of the posterior maxilla and autorotation of the mandible (rotation at the condyle) (Fig 4-57c).

Difficulty achieving acceptable esthetic results in the treatment of cases with Class II low mandibular planes and deep bites led to the development of a surgical treatment design in which the occlusal plane is deliberately altered. This treatment design has been used to successfully treat other dentofacial deformities as well. The clinician cannot arbitrarily decide to manipulate the occlusal plane angulation; this decision is made only when the desired results cannot be obtained by conventional treatment planning.

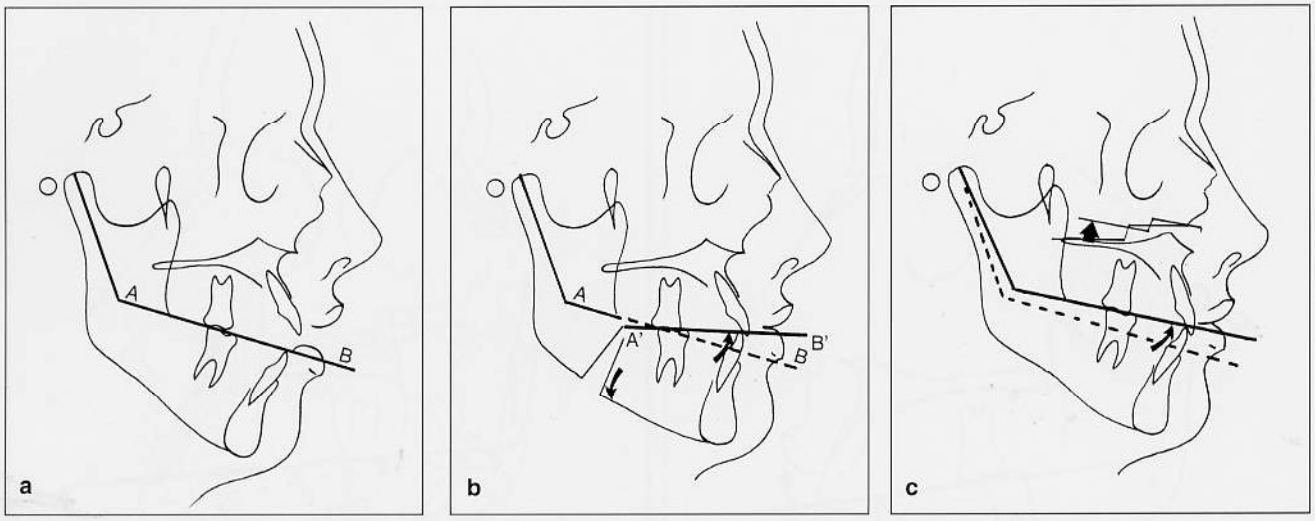


Fig 4-57 *(a)* Lateral cephalometric tracing of a patient with an anterior open bite. The relationship of the maxillary incisor to the lip line is favorable. The occlusal plane of the mandible (A-B) differs from the maxillary occlusal plane. *(b)* Apparent correction of the open bite by surgical adjustment of the mandible (A'-B'). The occlusal plane has been rotated counterclockwise from A-B to A'-B' (rotation at the surgical site). Stability is doubtful. *(c)* Surgical correction of the open bite by superior repositioning of the posterior maxilla and autorotation of the mandible (rotation at the condyle). Presurgical occlusal plane is denoted by a dashed line and postsurgical, by a solid line.

This change in occlusal plane angulation—which is also called manipulation, alteration, or rotation of the occlusal plane—might be better defined as a rotation of the maxillomandibular complex to enhance esthetic and functional treatment results. The rotation should take place around a preselected point in a clockwise or counterclockwise direction and thus will alter the occlusal plane. It is by no means an attempt to correct the occlusal plane angle to a normal angulation.

Manipulation of the occlusal plane: Geometry and planning

Surgical repositioning of the jaws involves complicated three-dimensional movements of geometrically complex structures. The diagnostic information gained from the preoperative clinical examination, study casts, and radiographic evaluation must be carefully integrated to establish the appropriate surgical treatment plan.

Alteration of the occlusal plane should be considered only if conventional treatment planning does not yield satisfactory results. It is extremely difficult to simply "place" or "select" a new occlusal plane without selecting a point around which to rotate the maxillomandibular complex or alter the occlusal plane. It is easier and more accurate, both in planning and in surgery, to rotate the maxillomandibular complex around a preselected point.

The geometry of maxillomandibular complex rotation is best illustrated by constructing a triangle involving the posterior nasal spine (PNS), anterior nasal spine (ANS), and pogonion (Pog) (Fig 4-58). Any point on the triangle posterior or inferior to ANS may be chosen as the rotation point. The location of the point and the direction of rotation are dictated by the esthetic requirements of each patient. Opposite esthetic results can be achieved by either clockwise or counterclockwise rotation of the maxillomandibular complex. In addition, the effects can be enhanced by moving the point more anteriorly or posteriorly between ANS and PNS or inferiorly or superiorly between ANS and Pog. The desired position of the maxillary incisor,

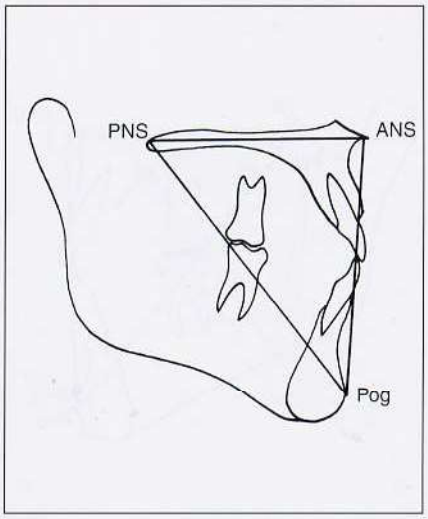


Fig 4-58 A triangle involving the posterior nasal spine (PNS), anterior nasal spine (ANS), and pogonion (Pog) is used to plan the rotation of the maxillomandibular complex.

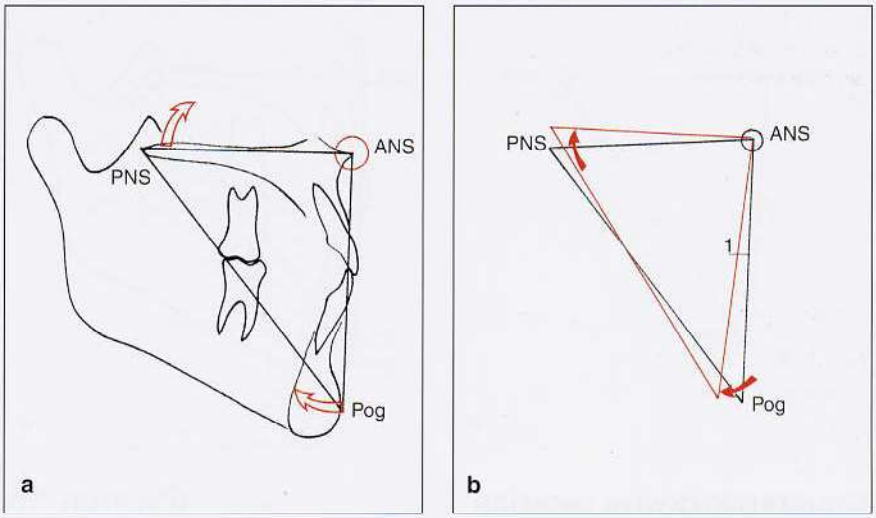


Fig 4-59 *(a)* Clockwise rotation of the triangle (maxillomandibular complex) around the ANS. *(b)* The vertical height of the anterior maxilla is maintained while the posterior maxilla is superiorly repositioned. The maxillary incisor (1) and pogonion rotate posteriorly.

paranasal anatomy, and chin prominence will help establish the point of rotation.

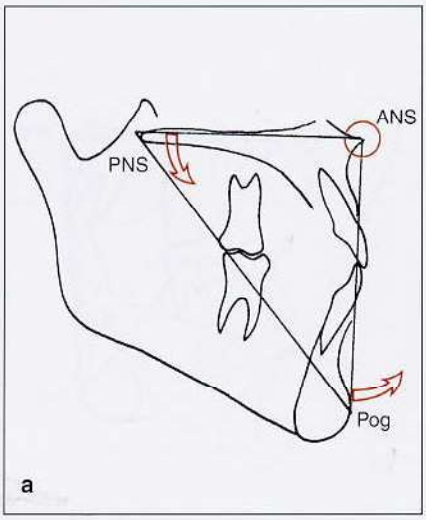
The selection of the precise point of maxillary rotation is guided primarily by the esthetic requirements of the patient. When patients require more upper lip and paranasal support (and less chin retraction), the maxillary incisor tip is used as the center of rotation. When no maxillary advancement is desired and definitive posterior displacement of the chin is planned, the rotation point is placed superiorly at ANS. The facial changes to be expected after rotation at different points and direction of rotations are described in the following sections.

Rotation point at the anterior nasal spine

Clockwise rotation

Surgical superior repositioning of PNS as a result of clockwise rotation around a point at ANS will result in the following changes (Fig 4-59):

1. Increased occlusal plane angle
2. Retraction of the maxillary incisor tip
3. Decreased maxillary incisor angulation
4. Decreased chin projection
5. Increased mandibular plane angle
6. Increased mandibular incisor angle



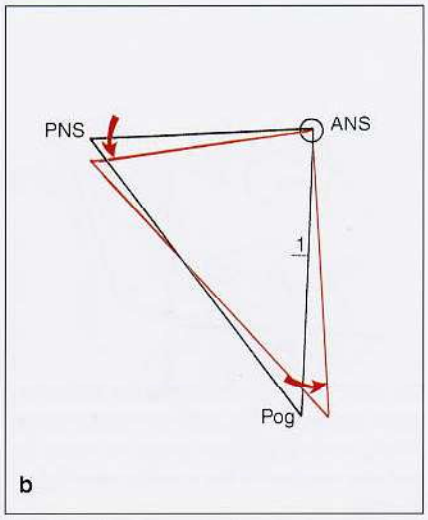


Fig 4-60 *(a)* A triangle (the maxillomandibular complex) is rotated counterclockwise around a point at the ANS. *(b)* The posterior maxilla is inferiorly repositioned. The pogonion and maxillary incisor (1) rotate forward and slightly superiorly.

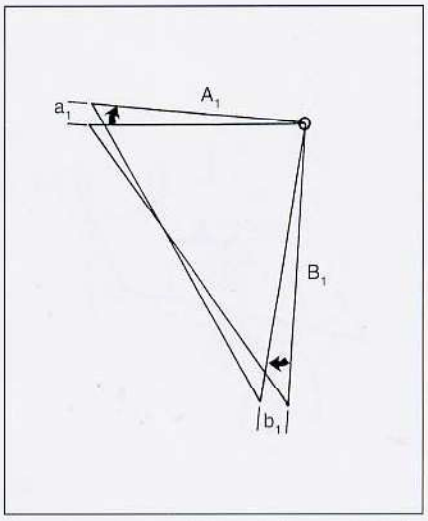


Fig 4-61 Center of clockwise rotation (in this case) is located at the ANS. a_1 = superior repositioning of the posterior maxilla; b_1 = posterior rotation (displacement of the pogonion); A_1 = maxillary length; B_1 = lower-third facial height.

Counterclockwise rotation

Downgrafting of the posterior maxilla (PNS) as a result of counterclockwise rotation around a point at ANS will result in the following changes (Fig 4-60):

1. Decreased occlusal plane angle
2. Decreased mandibular plane angle
3. Decreased mandibular incisor angle
4. Increased chin projection
5. Increased maxillary incisor angulation
6. Slight advancement of the maxillary incisor

The anterior or posterior movement of Pog (b_1) is greater than the superior or inferior repositioning of the posterior maxilla (a_1), because the height of the lower third of the face (ANS to Pog [B_1]) is greater than the anteroposterior maxillary length (ANS to PNS [A_1]) (Fig 4-61). The ratio of the movements may be expressed as:

$$\frac{a_1}{b_1} = \frac{A_1}{B_1}$$

Rotation point posterior to the anterior nasal spine

Clockwise rotation

The following effects of clockwise rotation will be enhanced by placing the rotation point further posterior (Fig 4-62):

1. Increased occlusal plane angle
2. Increased mandibular plane angle
3. Increased mandibular incisor angle
4. Increased lower facial height
5. Increased mandibular incisor angle

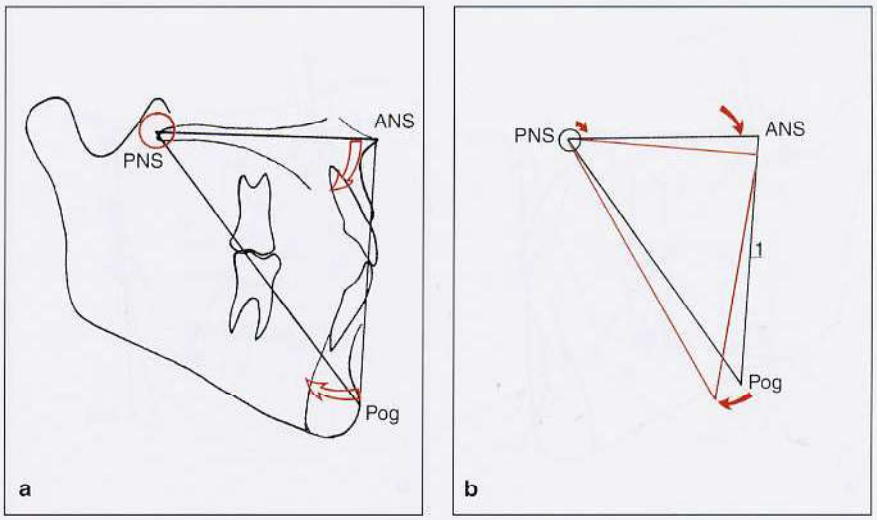


Fig 4-62 *(a)* A triangle (the maxillomandibular complex) is rotated clockwise around a point at the PNS. *(b)* The anterior maxilla is moved inferiorly, the maxillary incisor (1) moves posteriorly with a slight vertical increase, and the Pog rotates posteriorly and inferiorly.

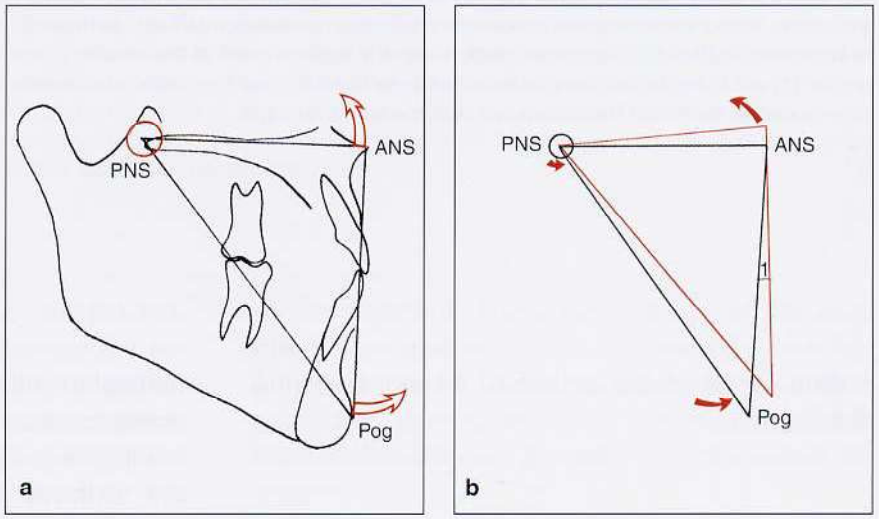


Fig 4-63 *(a)* A triangle (the maxillomandibular complex) is rotated counterclockwise around a point at the PNS. *(b)* The anterior maxilla is repositioned superiorly, while Pog and the maxillary incisors (1) are advanced.

6. Decreased maxillary incisor angulation
7. Decreased chin projection

Counterclockwise rotation

In counterclockwise rotation, the following effects of the rotation will increase the more posterior the point of rotation is placed (Fig 4-63):

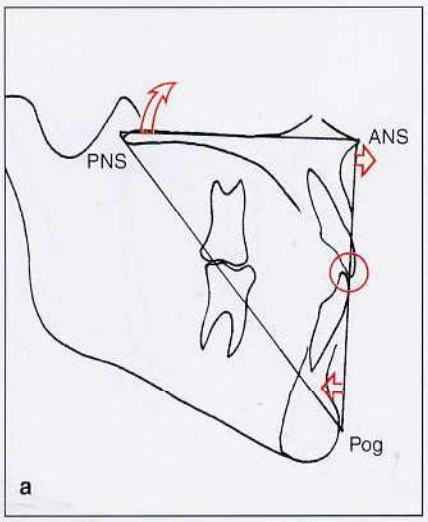
1. Decreased occlusal plane angle
2. Decreased mandibular plane angle
3. Decreased exposure of the maxillary incisors
4. Decreased anterior lower facial height
5. Decreased mandibular incisor angle
6. Increased chin projection
7. Increased maxillary incisor angulation

Rotation point inferior to the anterior nasal spine

Clockwise rotation

Surgical superior repositioning of the posterior maxilla as a result of rotation around a point inferior to ANS (eg, the maxillary incisor tip) will result in the following (Fig 4-64):

1. Increase in occlusal plane angle
2. Advancement of the maxilla at the ANS (b_2)
3. Decrease in the maxillary incisor angle (less decrease than is seen when the rotation point is at ANS)
4. Posterior repositioning of Pog (c_2) (less than when the rotation point is at ANS)



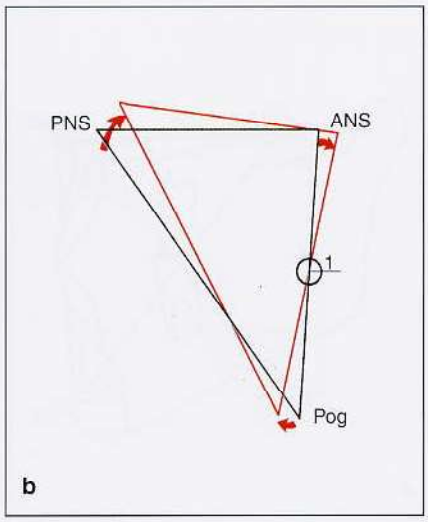


Fig 4-64 *(a)* Clockwise rotation of the maxillomandibular complex around the maxillary incisor tip. A counterclockwise rotation with a selected rotation point inferior to the ANS is seldom indicated. *(b)* Clockwise rotation with the rotation point at the maxillary incisor tip (1) will have the following effects: advance the ANS, set Pog back, and superiorly reposition the PNS. The incisor will become slightly upright.

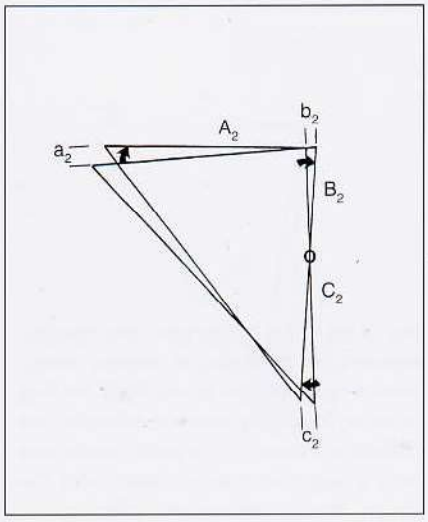


Fig 4-65 The ratio of the anterior movement of the ANS (b_2) to the posterior movement of Pog (c_2) is equal to the ratio between the distance from the ANS to the maxillary incisor tip (B_2) and the distance from incisor tip to Pog (C_2). A_2 represents the maxillary length, a_2 the amount of superior repositioning of the posterior maxilla.

The ratios of the extent of movements (Fig 4-65) are:

$$\frac{b_2}{c_2} = \frac{B_2}{C_2}$$

where B_2 = the distance from the ANS to the maxillary incisor tip and C_2 = the distance from the maxillary incisor tip to Pog.

Counterclockwise rotation

Counterclockwise rotation would result in posterior repositioning of the maxilla, which is very rarely indicated, technically difficult, and not recommended.

Indications for the rotation of the maxillomandibular complex

Figure 4-66a, the cephalometric tracing of a patient with a Class III malocclusion, illustrates the applicability of rotation of the maxillomandibular complex. The problem is characterized by vertical maxillary excess and mandibular anteroposterior excess.

First, a prediction tracing is created to test the esthetic effect of the conventional approach, which involves superior repositioning of the maxilla to permit autorotation and subsequent setback of the mandible. The cant of the occlusal plane, therefore, would be dictated by the inclination of the mandibular dental arch after autorotation. The prediction tracing is examined to assess whether the desired esthetic result can be achieved. The lower third of the face is still too prominent (a facial contour angle of –5 degrees) (Fig 4-66b). Superior repositioning of the posterior maxilla, however, allows for a clockwise rotation of the entire lower third of the face (maxillomandibular complex) around a center at the anterior nasal spine (Fig 4-66c). This modification of the operative plane could enable the surgeon to achieve a more ideal esthetic result and is tested on a second prediction tracing (compare Fig 4-66b with Fig 4-66c). A facial contour angle of –11 degrees has now been achieved.

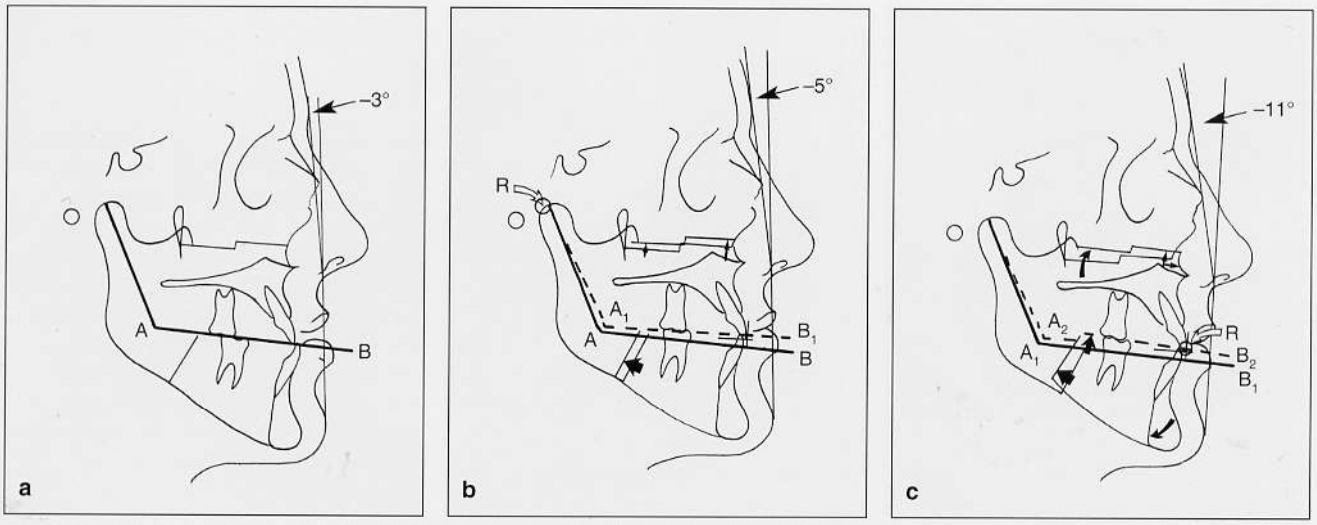


Fig 4-66 *(a)* Lateral cephalometric tracing of a patient with a vertical maxillary excess and mandibular anteroposterior excess. The occlusal plane (A-B) facial contour angle is −3 degrees. *(b)* Trial prediction tracing of the patient. The maxilla has been superiorly repositioned, and A_1-B_1, the new occlusal plane, is determined by the mandible after autorotation around condyle (R). The mandible is now set back according to this plane. Note the facial contour angle of −5 degrees. The chin is still too prominent. *(c)* Surgical prediction tracing of the patient. After autorotation of the mandible (A_1-B_1), the occlusal plane is manipulated by further superior repositioning of the posterior maxilla (A_2-B_2). The center of rotation (R) is now located at the ANS. A more esthetic facial contour angle is established (−11 degrees) as a result of the further distalization of the chin point.

In addition to the esthetic objectives, anatomic considerations also influence the selection of the center of rotation and the extent of change of the occlusal cant. Excessive superior repositioning of the posterior nasal spine (more than 5 to 6 mm) may compromise the nasal airway. Where indicated, therefore, it may be necessary to perform a horseshoe-shaped Le Fort I osteotomy to separate the dentoalveolar portions of the maxilla from the palate, which thus remains attached to the nasal septum. The vertical dimension of the nasal airway is thereby maintained, while the dentoalveolar segments are free to be repositioned.

An excessive change in the occlusal plane angle could affect the balance between the condylar guidance of the eminentia articularis and the cuspal angulations responsible for protrusive disclusion. However, the interrelationship and possible effects of changes require further research.

Clockwise rotation of the distal segment of the mandible may lead to interference of the step of the horizontal osteotomy on the medial side of the ramus. This step may need to be contoured (Fig 4-67a) to allow free movement of the segment. The anterior edge of the segment often also requires contouring (Fig 4-67b). The method for developing a cephalometric prediction tracing involving the rotation of the maxillomandibular complex is discussed in chapter 3.

Clockwise rotation of the maxillomandibular complex around a point posterior to the nasal spine allows vertical lengthening of the anterior facial height. In Case E.H., shown in Figs 4-68 and 4-69, the maxillomandibular complex is rotated clockwise around a point at the zygomatic buttress. Figure 4-68b shows the expected soft tissue result after conventional treatment planning—a flat labiomental curve. The expected soft tissue result after rotation of the maxillomandibular complex is demonstrated in Fig 4-68c.

Rotation of the maxillomandibular complex around a point at the tip of the maxillary incisors is illustrated by Case B.T. in Figs 4-70 to 4-73. The treatment is complicated by the fact that the first maxillary premolars were extracted when the patient was young.

Case G.M. demonstrates clockwise rotation of the maxillomandibular complex around the anterior nasal spine (Figs 4-74 to 4-78).

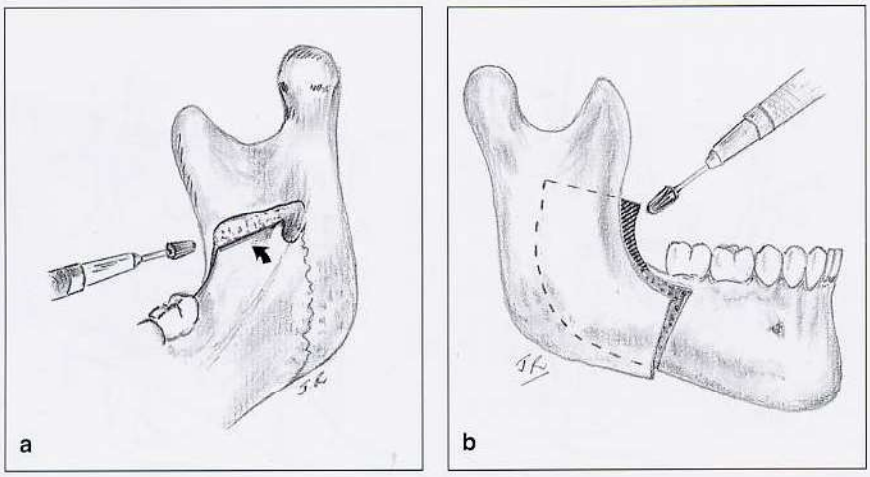


Fig 4-67 *(a)* Before the posterior aspect of the distal segment is rotated posteriorly, the bone on the proximal segment above the horizontal part of the ramus osteotomy must be removed to allow the segments to fit passively together. If this bony interference is not removed and the segments are forced together by rigid fixation, the condyle will be displaced laterally. *(b)* After clockwise rotation, the vertical part of the distal segment may be pronounced and therefore should be contoured.

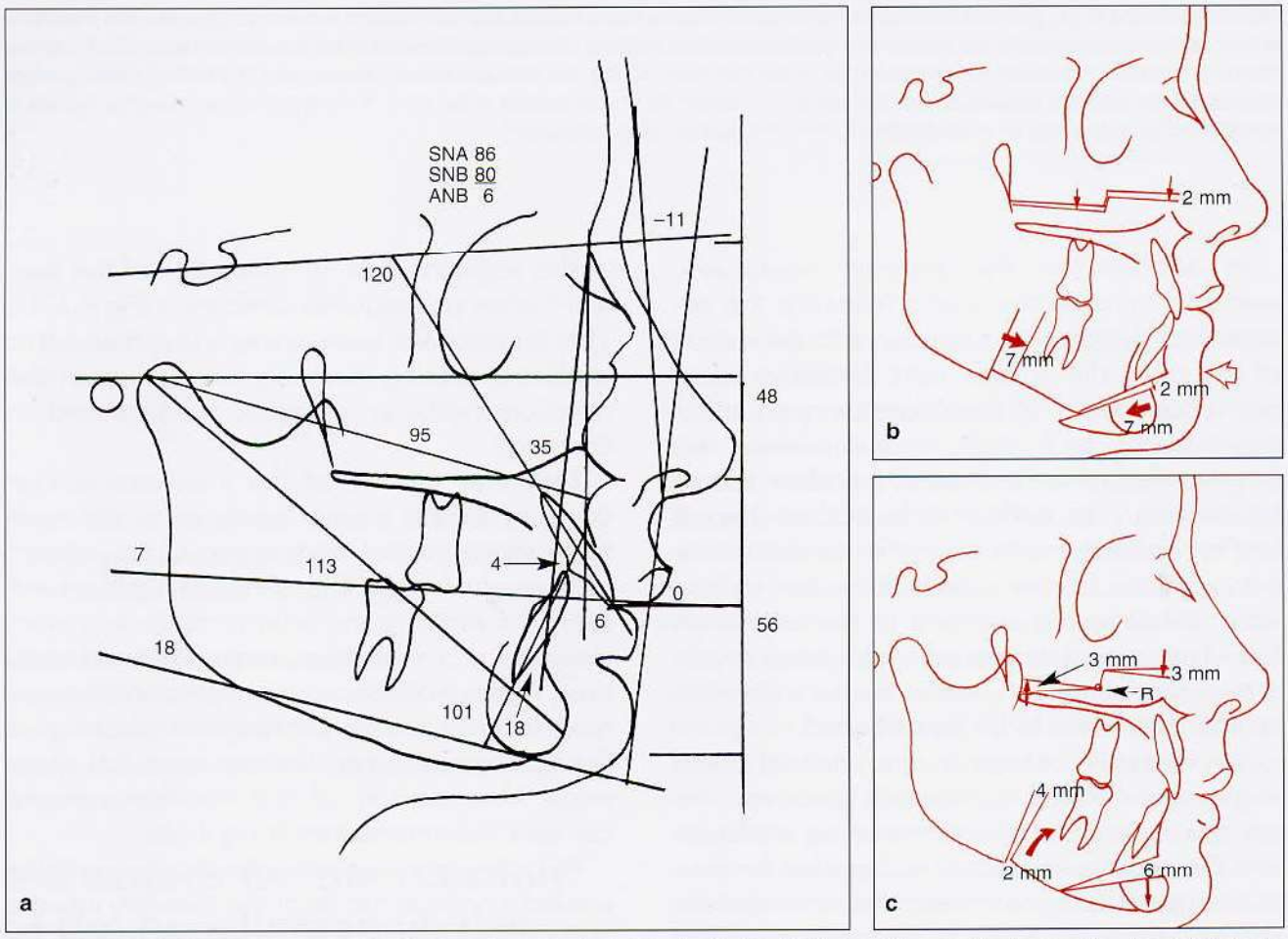


Fig 4-68 Case E.H. *(a)* Pretreatment cephalometric analysis. *(b)* Surgical plan. *(c)* The maxillomandibular complex is rotated clockwise around the zygomatic buttress (R). Note the difference between the conventional profiles in *(b)* and *(c)*.

Fig 4-69 Case E.H. Pretreatment frontal view *(a)*; profile view *(b)*; three-quarters view *(c)*; occlusion, right *(d)*; occlusion, center *(e)*; and occlusion, left *(f)*. Treatment results: frontal view *(g)*; profile view *(h)*; three-quarters view *(i)*; occlusion, right *(j)*; occlusion, center *(k)*; and occlusion, left *(l)*.

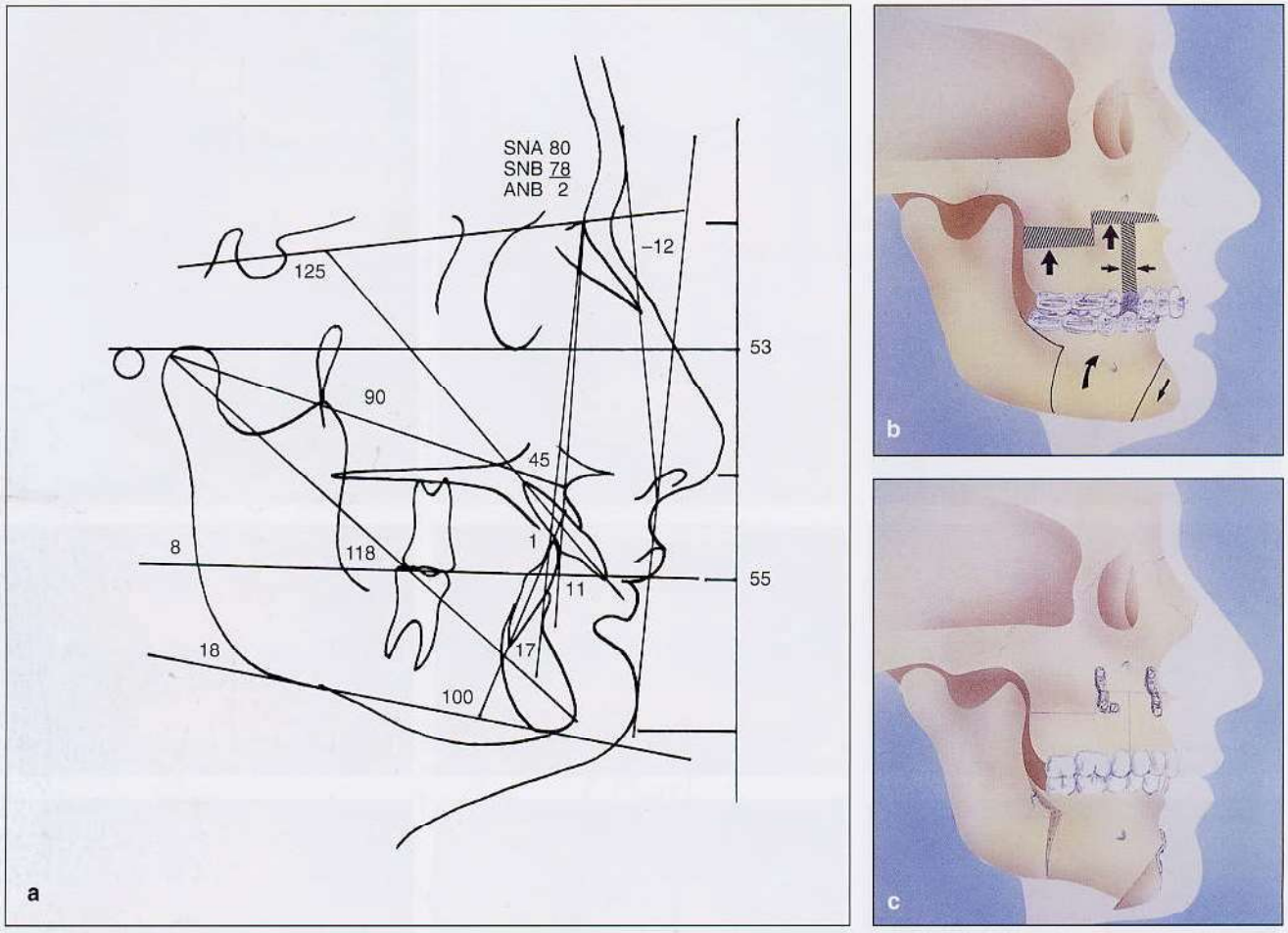


Fig 4-70 Case B.T. Pretreatment cephalometric analysis *(a)* and surgical plan *(b and c)*. Note that the extraction spaces are closed surgically.

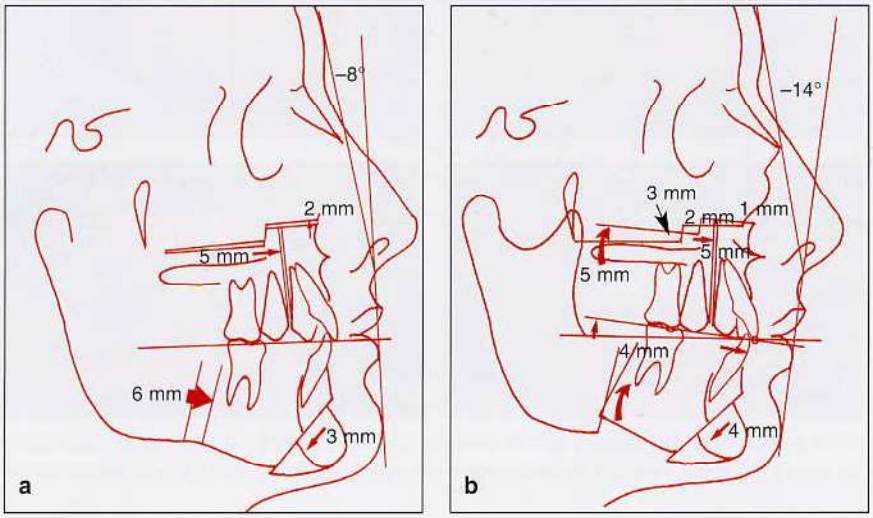


Fig 4-71 Case B.T. *(a)* Surgical prediction tracing done according to conventional treatment planning. Note that the chin appears prominent (facial contour angle is -8 degrees), and further reduction of the chin will obliterate the labiomental curve. *(b)* The maxillomandibular complex is rotated clockwise around the incisor tip, facilitating a more convex profile.

Fig 4-72 Case B.T. *(a)* Pretreatment occlusion. *(b)* Presurgical occlusion. *(c)* Posttreatment occlusion.

Fig 4-73 Case B.T. *(a)* Pretreatment frontal view. *(b)* Pretreatment profile view. *(c)* Posttreatment frontal view. *(d)* Posttreatment profile view.

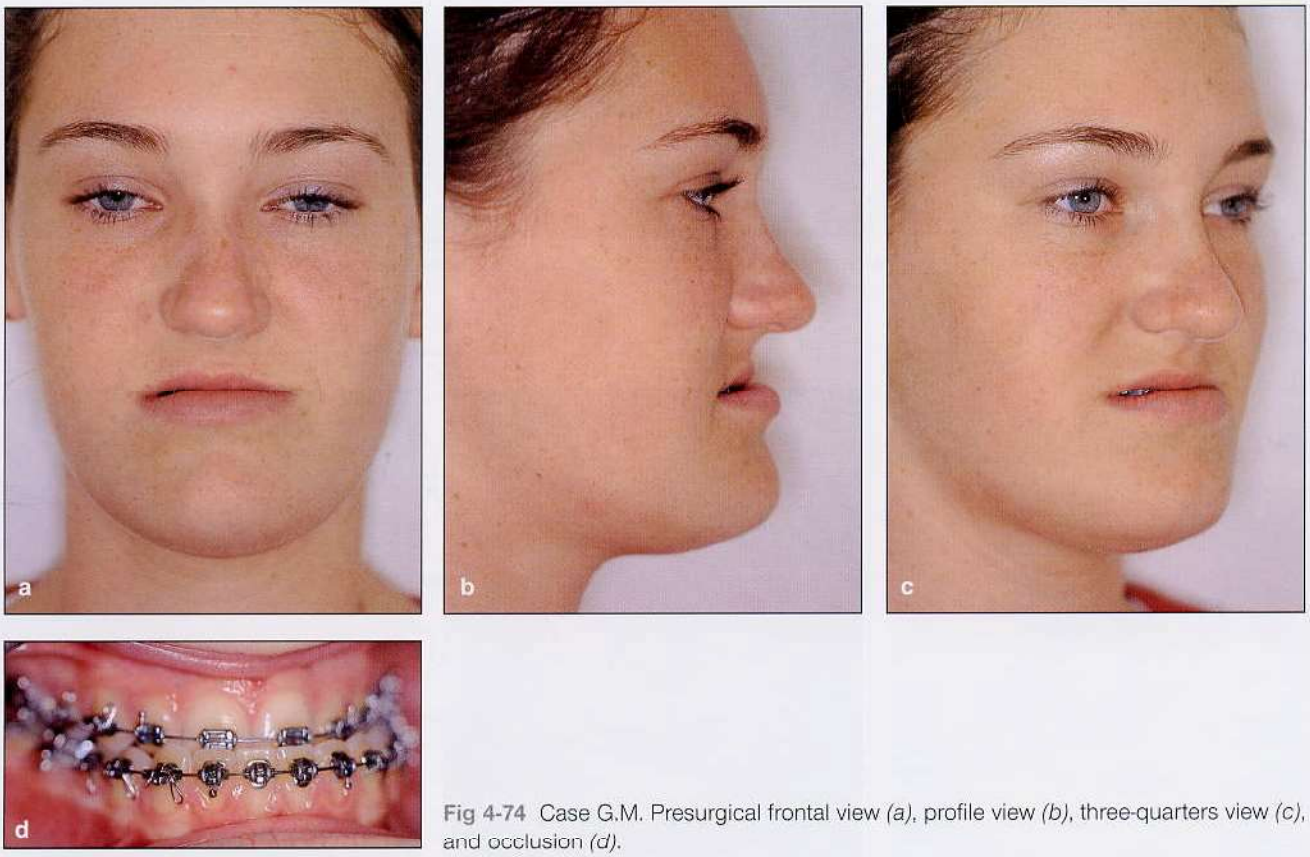


Fig 4-74 Case G.M. Presurgical frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

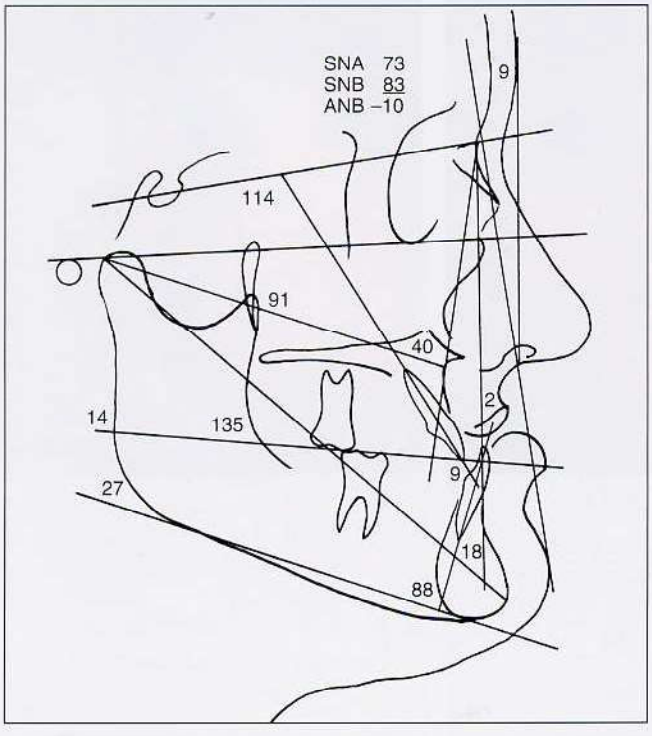


Fig 4-75 Case G.M. Presurgical cephalometric tracing analysis. Maxillary anteroposterior deficiency: SNA = 73 degrees; mandibular anteroposterior excess: SNB = 83 degrees; Class III skeletal relationship: ANB = −10 degrees; concave profile: facial contour angle = 9 degrees.

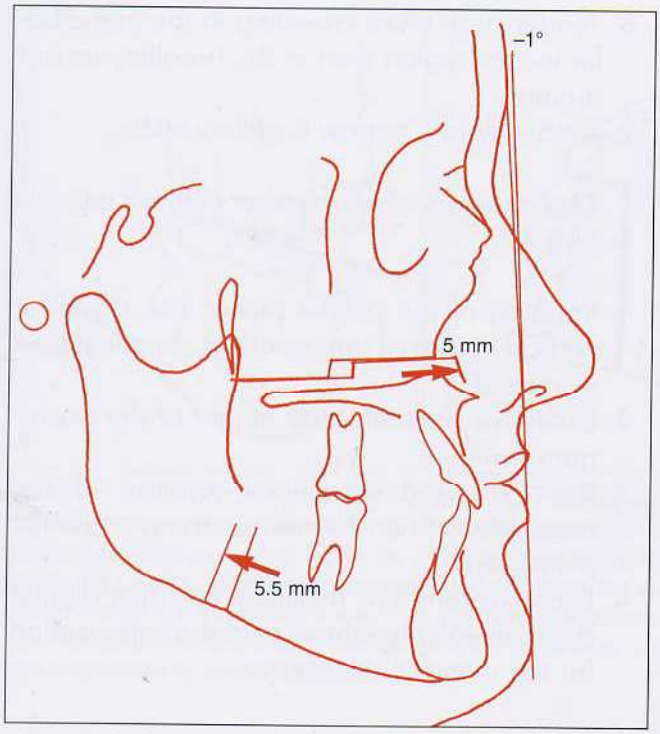


Fig 4-76 Case G.M. Presurgical visual treatment objective. Conventional treatment planning does not render an esthetically pleasing profile. The facial contour still appears concave (facial contour angle = −1 degree).

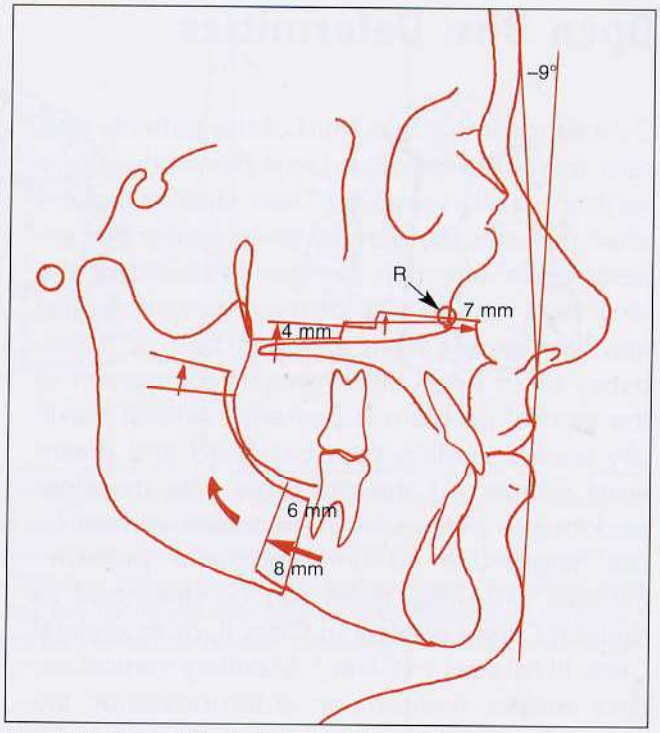


Fig 4-77 Case G.M. Clockwise rotation of the maxillomandibular complex at point R allows for a larger amount of mandibular setback and a more pleasing facial contour angle of −9 degrees.

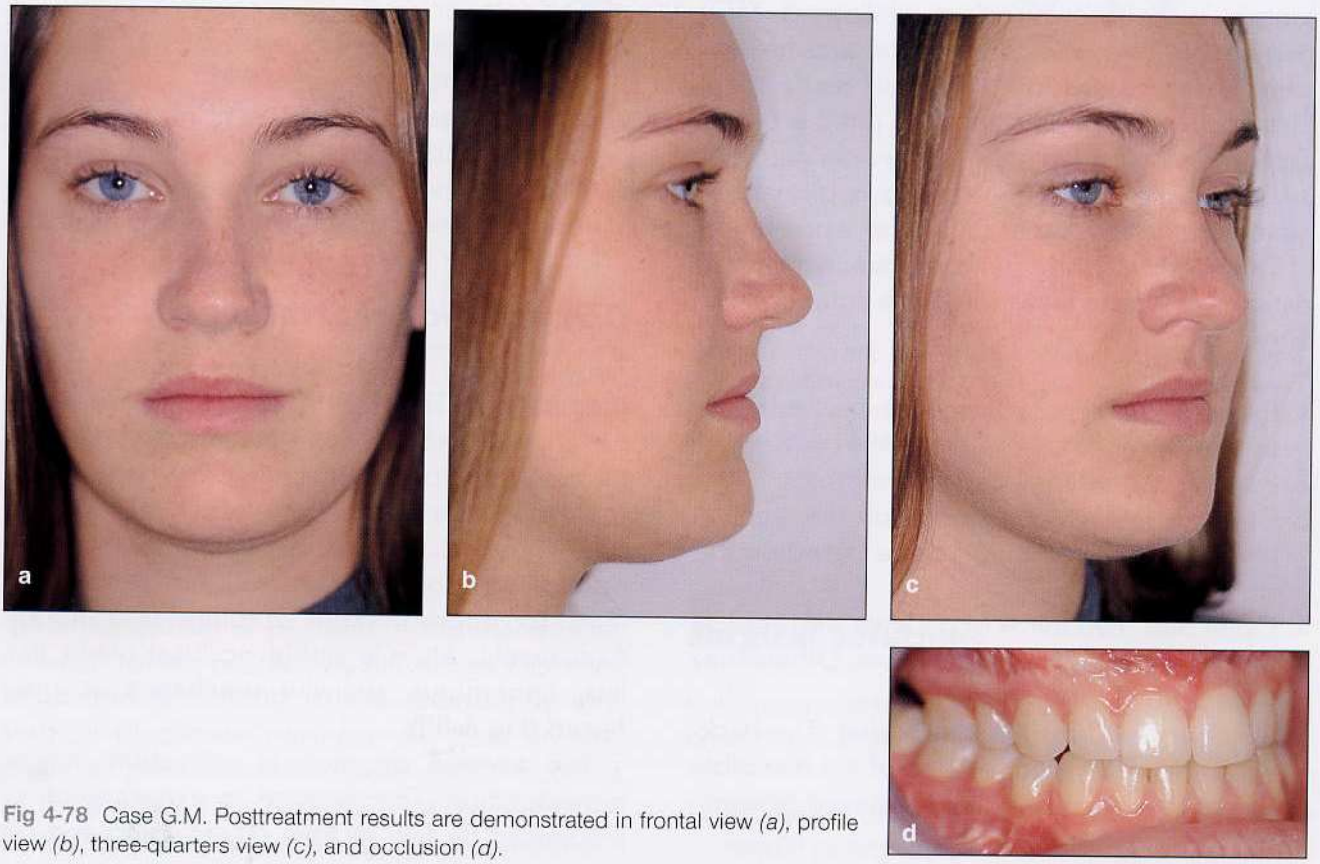


Fig 4-78 Case G.M. Posttreatment results are demonstrated in frontal view *(a)*, profile view *(b)*, three-quarters view *(c)*, and occlusion *(d)*.

Open Bite Deformities

Data suggest that one third of the patients who seek treatment for dentofacial deformities have vertical maxillary excess. Their chief complaint often includes the gummy smile and/or the anterior open bite that are the hallmarks of the long face. Nearly 60% of patients with vertical maxillary excess have an open bite or a tendency to an open bite. A major component of the vertical problem is posterior vertical maxillary excess leading to a backward and downward rotation of the mandible. We therefore seldom see patients with increased vertical facial height and no anteroposterior problem. Patients with long faces can be described as skeletal Class I rotated to Class II, or as skeletal Class III rotated to Class I. Maxillary vertical excess makes mandibular anteroposterior excesses better and mandibular anteroposterior deficiencies worse.

Patients with long faces who have anterior open bites are very likely to be labeled as having a tongue thrust because they place the tip of the tongue in the opening when swallowing. Most people, however, position their tongues forward when trying to swallow with their teeth apart. This positioning of the tongue is often a necessary physiologic adaptation to the open bite, not its cause. The size of the tongue is probably a more important factor in causing an open bite.

The following are clinical characteristics of patients with long faces who have anterior open bites:

1. Excessive anterior facial height, particularly in the lower third.
2. Increased interlabial gap (> 4 mm).
3. Gummy smile. Assessment of the vertical maxillary excess should not be based on the smile.
4. Open bite. Two thirds of patients with vertical maxillary excess have open bites. Others may have normal or deep bites.
5. Tendency to Class II malocclusion. The backward and downward rotation of the mandible affects the relative anteroposterior position of the mandible.
6. Tendency to more crowding in the mandibular incisor region than in the maxillary incisor region.
7. Tendency to a narrow maxillary arch.

Cephalometric characteristics of these patients include:

1. Rotation of the palatal plane. The posterior vertical height of the maxilla is almost always increased.
2. Excessive dentoalveolar height of the posterior maxilla.
3. Backward and downward rotation of the mandible with an increase in the mandibular plane angle.
4. Excessive anterior maxillary and mandibular dentoalveolar height as partial compensation for the mandibular rotation.

Class I open bite

Clinical characteristics

1. Vertical maxillary excess—more posterior than anterior
2. Mandible rotated clockwise (backward)
3. Increased interlabial gap
4. Often, increased exposure of maxillary incisors under the upper lip
5. Often, transverse maxillary deficiency
6. Possibly a skeletal Class III rotated to a Class I

Orthodontic preparation

Two decisions have to be made in orthodontic preparation. The first is to decide between continuous archwire (one-piece) and segmental arch (multipiece) mechanics. When a dual occlusal plane exists, segmental arch orthodontics is indicated to avoid possible orthodontic extrusion of anterior teeth, which may lead to unpredictable stability (Fig 4-79). Conversely, when a single occlusal plane exists, continuous archwire mechanics is preferred (Fig 4-80).

The second decision is extraction versus nonextraction. The decision to extract teeth is influenced by two factors: *(1)* crowding and *(2)*

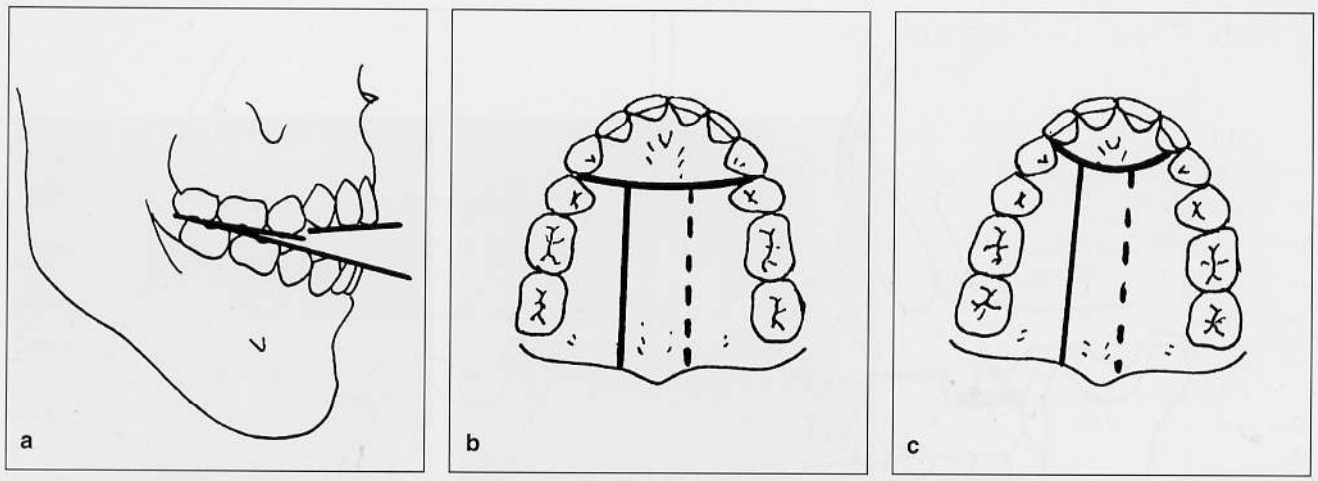


Fig 4-79 *(a)* Dual occlusal plane of the maxilla. The maxillary arch is aligned in three segments, and the segments are aligned to conform to the mandibular arch form. *(b)* Interdental osteotomies are performed between the canines and premolars to allow for surgical correction of vertical discrepancies. A palatal osteotomy (unilateral or bilateral) is performed lateral to the nasal septum and medial to the greater palatine neurovascular bundle to allow the correction of transverse maxillary discrepancies. The orthodontist should ensure that the intercanine width is sufficient to accommodate the mandibular arch. *(c)* Interdental osteotomies performed between the lateral incisors and canines allow the surgeon to control the intercanine distance. Correction of transverse discrepancies is facilitated by palatal osteotomies.

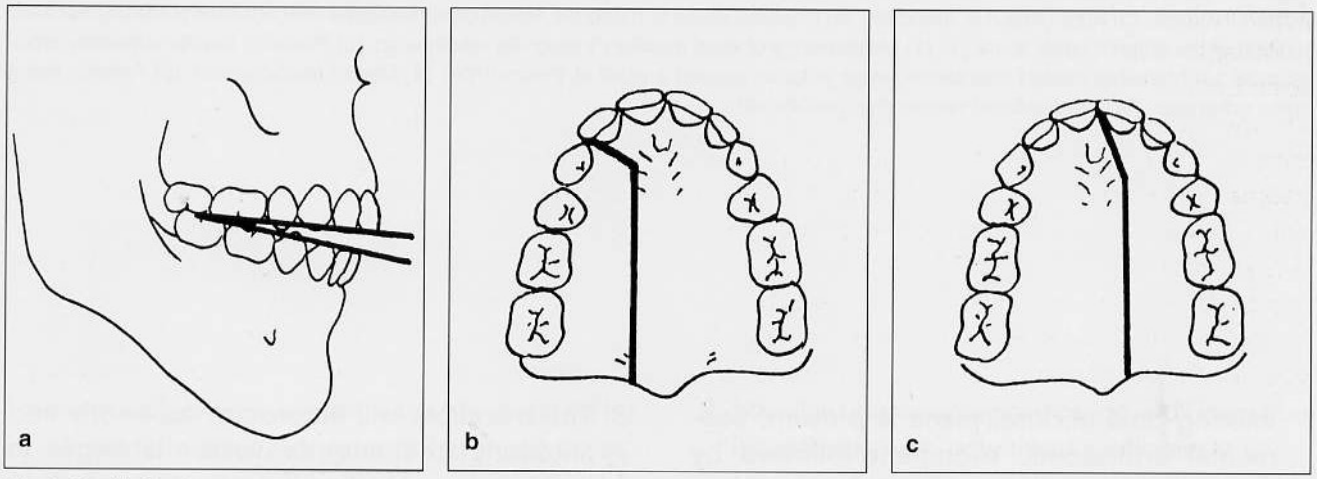


Fig 4-80 *(a)* Single occlusal plane of the maxilla. A continuous arch will be used to level the maxillary occlusion on a single plane. Maxillary transverse arch discrepancy is corrected by segmental surgery, and, depending on the orthodontic arch alignment, the position of the interdental osteotomy may vary: *(b)* a unilateral segmental osteotomy with interdental osteotomy between lateral incisor and canine teeth or *(c)* a maxillary midline osteotomy with an interdental osteotomy between the maxillary central incisors.

the anteroposterior position of the mandibular incisors. When no mandibular surgery is contemplated (according to the orthodontic and surgical prediction tracings), the final anteroposterior position of the maxilla will be dictated by the anteroposterior position of the mandibular incisors after autorotation of the mandible.

Surgical solutions

Following are surgical solutions to Class I open bites (Fig 4-81):

1. Superiorly reposition the maxilla (using segmental or one-piece mechanics). When a pre-

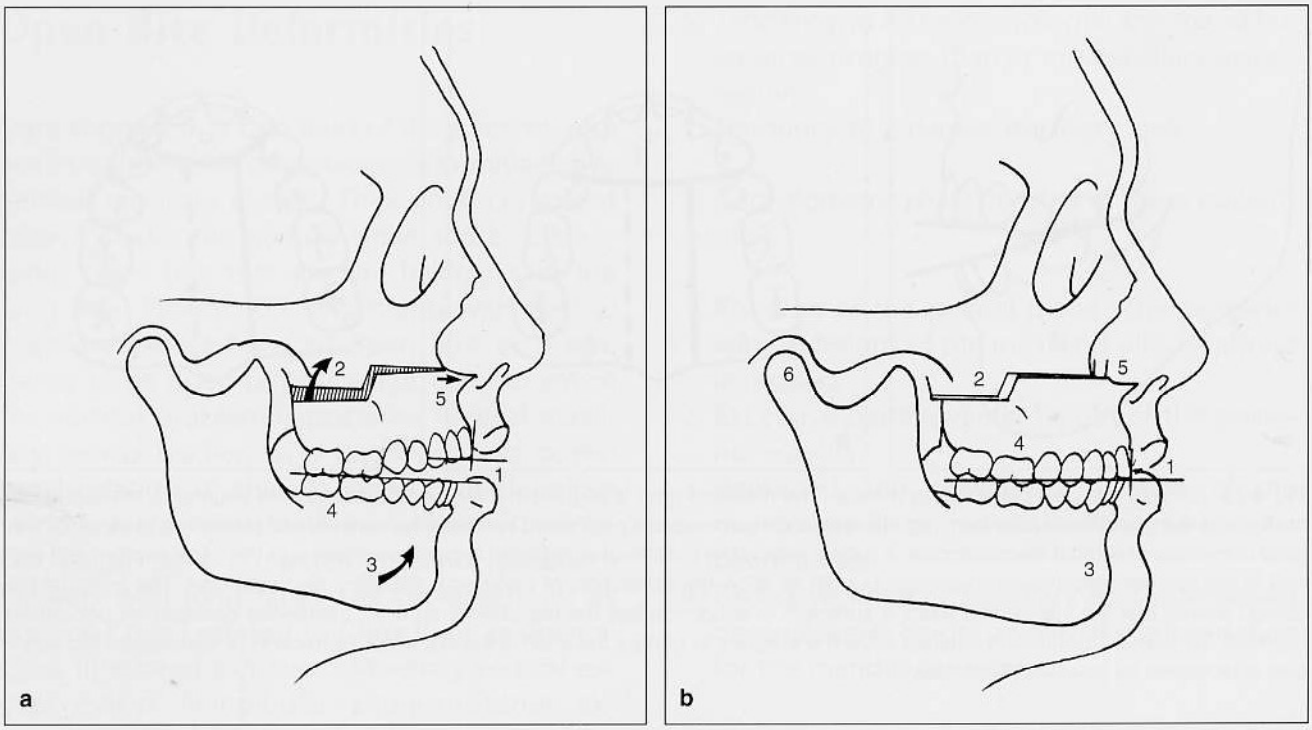


Fig 4-81 *(a)* (1) Maintenance of maxillary incisor–upper lip relationship (anteroposterior and vertical). (2) Superior repositioning of posterior maxilla. (3) Autorotation of mandible. (4) Occlusal plane of mandible, which determines the final occlusal plane. (5) Forward rotation of the anterior nasal spine. *(b)* (1) Maintenance of ideal maxillary incisor–lip relationship. (2) Posterior maxilla superiorly repositioned. (3) Mandible rotated counterclockwise (rotation around a point at the condyle). (4) Class I malocclusion. (5) Anterior nasal spine advanced. (6) Condyle-fossa relationship maintained.

existing dual occlusal plane is present, segmental orthodontic alignment followed by segmental surgical correction is indicated.

2. Surgically expand the maxillary buccal segments (segmental surgery). In cases with a dual occlusal plane and transverse maxillary deficiency, a three-piece Le Fort I osteotomy with interdental osteotomies between the lateral incisor and canine is usually performed. Single maxillary occlusal plane orthodontic preparation requires a two-piece Le Fort I osteotomy, and depending on the orthodontic preparation of the two segments, the interdental osteotomy is usually performed between the maxillary central incisors or unilaterally between the lateral incisor and canine.
3. The mandible will autorotate superiorly and anteriorly (the anterior vector is larger in high-angle cases than in low-angle cases).

Individuals with facial esthetic features indicative of maxillary anteroposterior deficiency (large nose, convex nasal dorsum, deficient paranasal anatomy, lack of supratip break, and poor lip support) would benefit from the obligatory maxillary advancement. Individuals with normal midface esthetic features will experience unesthetic changes with isolated superior and anterior repositioning of the maxilla. For these individuals, simultaneous mandibular setback is necessary to avoid undesirable maxillary advancement. Finally, the facial esthetics of a small percentage of individuals may necessitate

Fig 4-82 Case K.S. Presurgical frontal view *(a)*, profile view *(b)*, and occlusion *(c)*. Note the placement of white lingual buttons on the buccal surfaces of the maxillary teeth just prior to surgery.

more maxillary advancement than is dictated by the mandible after autorotation. In these cases, the clinician should consider additional advancement of the maxilla, which will require simultaneous surgical advancement of the mandible.

The anteroposterior position of the chin is not a primary determining factor in the cases discussed above. In most of these patients, excessive or deficient chin projection can be corrected by an appropriate genioplasty; however, the shape of the chin and the depth of the labiomental fold should be considered.

In summary, the surgical solutions may include:

1. Maxillary superior repositioning with or without genioplasty
2. Maxillary superior repositioning with mandibular setback, with or without genioplasty
3. Maxillary superior repositioning with mandibular advancement, with or without genioplasty
4. Possible maxillary superior repositioning in one piece (more posterior than anterior, as indicated by the mandibular occlusal plane after autorotation) or in segments, allowing differential superior repositioning of the anterior and posterior segments and simultaneous expansion of the buccal segments (again, as dictated by the occlusal plane of the mandible and the mandibular dental arch form)

Correction of a Class I anterior open bite is demonstrated in Figs 4-82 to 4-86 for Case K.S.

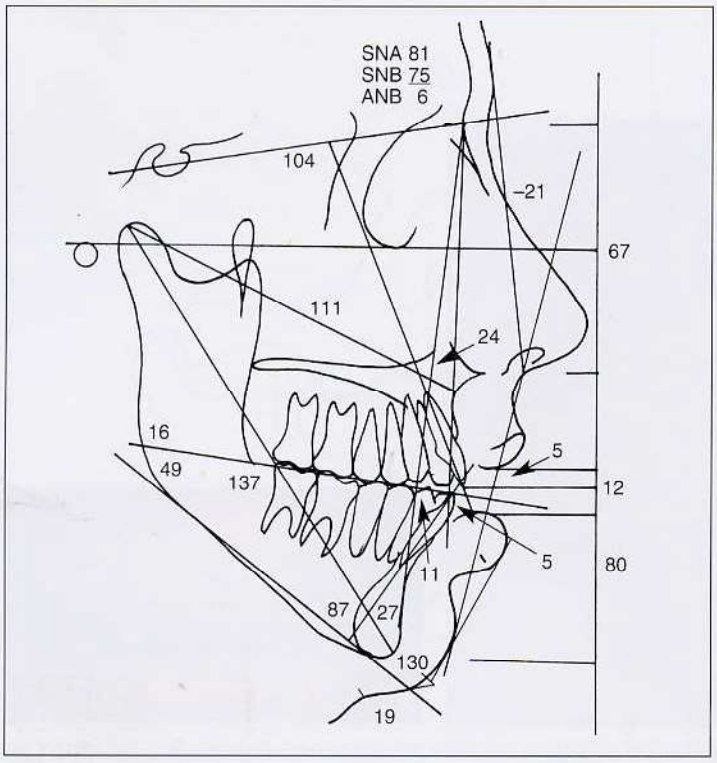


Fig 4-83 Case K.S. Presurgical cephalometric analysis. Posterior vertical maxillary excess: interlabial gap = 12 mm, increased lower facial height: middle to lower third = 67:80 mm; slight anterior maxillary vertical excess: maxillary incisor exposure = 5 mm; convex profile: facial contour angle = −21 degrees; mandible rotated clockwise because of vertical maxillary excess: mandibular plane = 49 degrees; microgenia: lip-chin-throat angle = 130 degrees, chin-throat length = 19 mm.

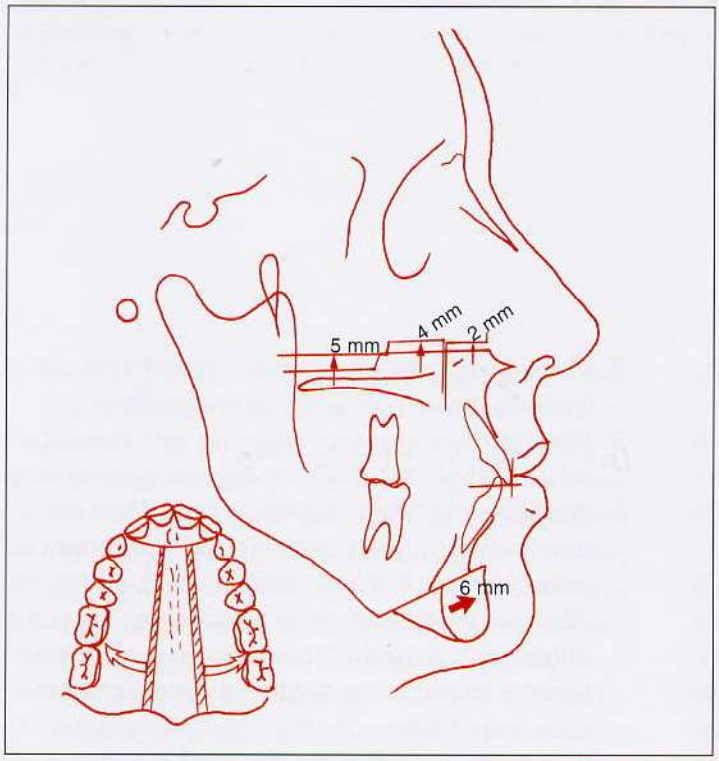


Fig 4-84 Case K.S. Surgical cephalometric visual treatment objective—Le Fort I maxillary osteotomy: superior repositioning of posterior maxillary segments (5 mm posterior and 4 mm anterior), superior repositioning of anterior maxillary segment (2 mm), expansion of the posterior segments *(inset)*, counterclockwise autorotation of the mandible, and advancement genioplasty (6 mm).

Fig 4-85 Case K.S. Immediate postsurgical occlusion. Note the interdental wires placed around the presurgically placed buccal brackets of the teeth next to the interdental osteotomies. Brackets are placed on all the teeth just prior to surgery to facilitate intermaxillary fixation during surgery and the placement of elastics after surgery.

Fig 4-86 Case K.S. Posttreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

Class II open bite

Clinical characteristics

1. Increased lower facial height
2. Recessive chin
3. Vertical maxillary excess
4. Often, excessive exposure of maxillary incisors
5. Increased interlabial gap
6. Skeletal Class II relationship
7. Transverse maxillary deficiency (posterior crossbite)
8. Increased mandibular plane angle
9. Could be a skeletal Class I rotated to a Class II

Orthodontic preparation

1. One-piece Le Fort I osteotomy
   - Level, align, and coordinate the maxillary arch, and align the mandibular arch.
   - Do not attempt to close the open bite by expansion of the buccal segments, extrusion of the anterior teeth, or intrusion of the posterior teeth.
   - Expand buccal segments of teeth only where the teeth are palatally inclined in relation to the basal bone.
2. Segmental Le Fort I osteotomy
   - Level and align the maxillary dental arch in segments.

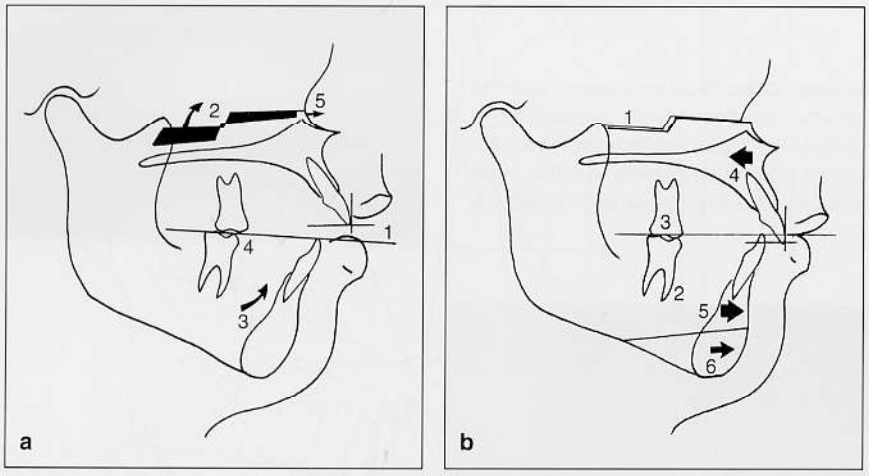


Fig 4-87 *(a)* (1) Maintain maxillary incisor–upper lip relationship (anteroposterior and vertical). (2) Superiorly reposition the posterior maxilla. (3) Mandible will autorotate. (4) The mandibular occlusal plane determines the final occlusal plane. (5) The anterior nasal spine is rotated forward. *(b)* (1) The posterior maxilla is superiorly repositioned. (2) The mandible has autorotated. (3) There is still a Class II malocclusion with an increased overjet. Options include maxillary setback (seldom used) (4), mandibular advancement (5), and genioplasty advancement (6).

- Align the segments to be compatible with the mandibular arch.
- Deviate the roots at the intended interdental osteotomy areas.
- Do not attempt to expand or close bites orthodontically.
- Level and align the mandibular arch.

Surgical solutions

Following are surgical solutions to Class II open bites (Fig 4-87):

1. Superior repositioning of the maxilla (total or segmental). The open bite can be corrected by more superiorly repositioning the posterior maxilla (segment) than the anterior maxilla.
2. Surgical expansion of buccal segments by segmental surgery.
3. Autorotation of the mandible.
4. Surgical advancement of the mandible.
5. Advancement genioplasty.

As a consequence of superior repositioning of the maxilla, the mandible will rotate counterclockwise (superiorly and forward) around a point at or just behind the condyle. The forward vector may be sufficient to allow only superior repositioning of the maxilla with no anteroposterior change. Cases with a high mandibular plane angle will have more forward rotation of the mandibular incisors than will low-angle cases.

Individuals who do not require mandibular advancement may require slight posterior movement of the maxilla; however, this movement will compromise the facial esthetic results. For patients with normal midface facial esthetics and especially for those with large noses, deficient concave paranasal areas, or obtuse nasolabial angles, maxillary setback should not be attempted. These patients require simultaneous superior repositioning of the maxilla and advancement of the mandible. The above principle is demonstrated in Fig 4-88.

Case K.P.

This 32-year-old patient sought treatment after being told by her general practitioner that she would eventually lose her teeth as a consequence of her open bite.

Main complaint

The patient's main complaint was her inability to maintain closure of her mouth and difficulty in chewing, which was sometimes socially embarrassing.

Medical history

The patient has asthma and takes medication only before physical exercise.

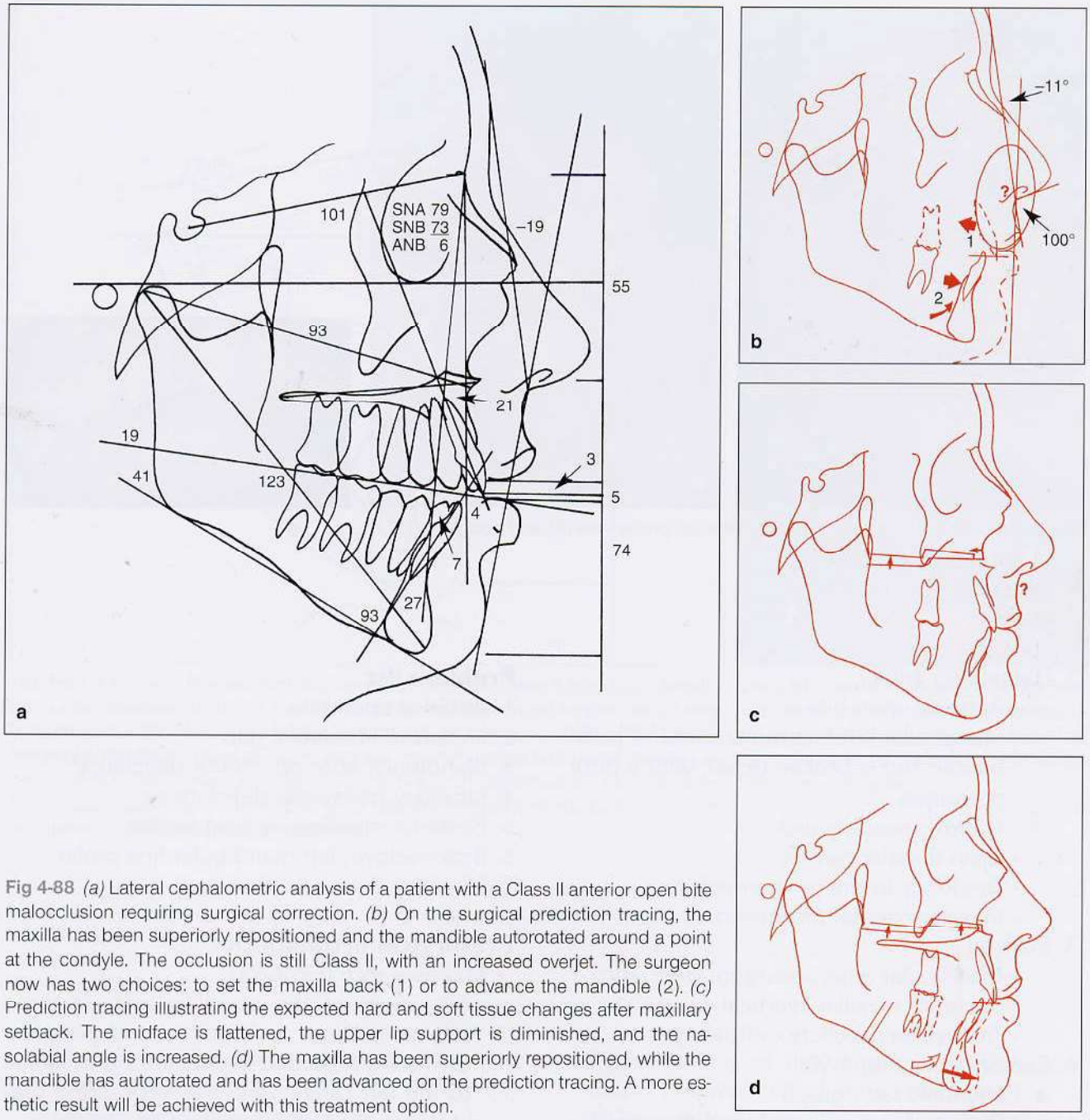


Fig 4-88 *(a)* Lateral cephalometric analysis of a patient with a Class II anterior open bite malocclusion requiring surgical correction. *(b)* On the surgical prediction tracing, the maxilla has been superiorly repositioned and the mandible autorotated around a point at the condyle. The occlusion is still Class II, with an increased overjet. The surgeon now has two choices: to set the maxilla back (1) or to advance the mandible (2). *(c)* Prediction tracing illustrating the expected hard and soft tissue changes after maxillary setback. The midface is flattened, the upper lip support is diminished, and the nasolabial angle is increased. *(d)* The maxilla has been superiorly repositioned, while the mandible has autorotated and has been advanced on the prediction tracing. A more esthetic result will be achieved with this treatment option.

Clinical examination

1. Soft tissue
   a. Frontal view (Fig 4-89a)
      - Increased interlabial distance
      - Increased lower facial third
      - Nasal asymmetry

   b. Profile view (Fig 4-89b)
      - Convex profile
      - Increased lower facial third height
      - Increased interlabial distance
      - Mandibular anteroposterior deficiency
      - Protruding upper lip
      - Acute lip-chin-throat angle

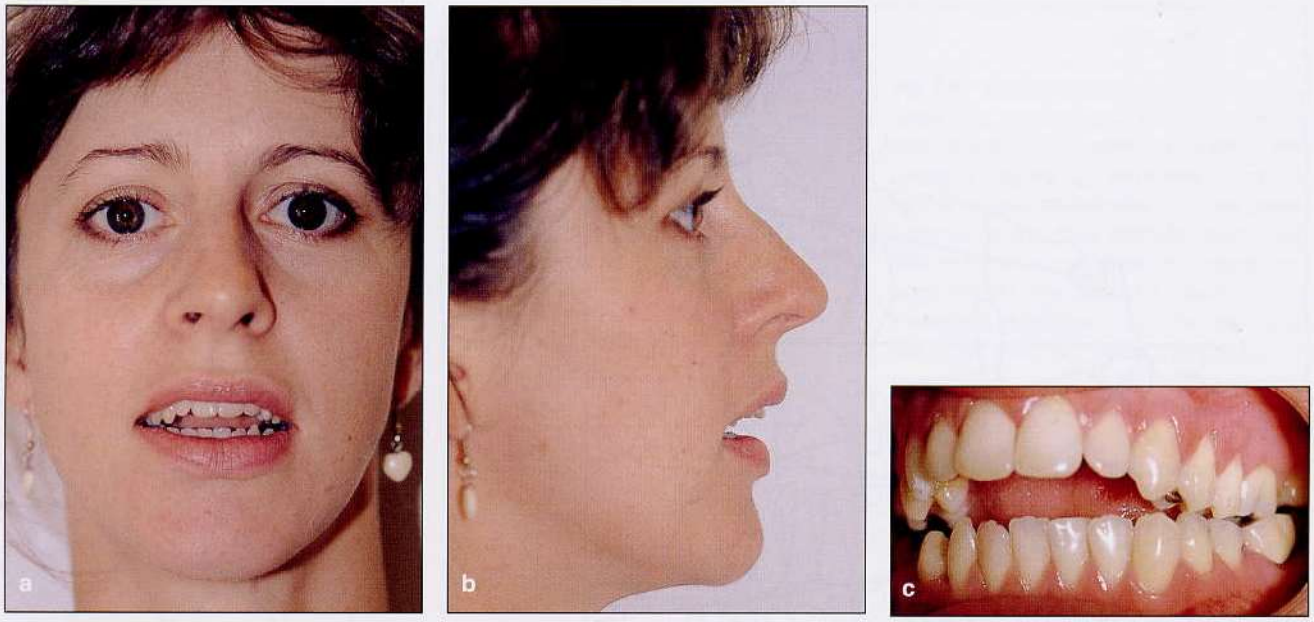


Fig 4-89 Case K.P. Pretreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

2. Dental (Fig 4-89c)
   - Anterior open bite
   - Mandibular left first molar root has been treated but is broken down, with a poor prognosis
   - Narrow maxillary arch
   - Class II malocclusion
   - Tendency to posterior crossbites
   - Maxillary dental protrusion
3. Skeletal
   - Mandibular anteroposterior deficiency
   - Posterior maxillary vertical excess
   - Transverse maxillary deficiency
4. Radiographic (Fig 4-90)
   a. Panoramic radiograph
      - Broken-down crown of the left mandibular first molar (tooth has had root canal treatment)
      - Several restored teeth
   b. Cephalometric
      - Class II malocclusion
      - Mandible rotated clockwise
      - Vertical excess of the posterior maxilla
      - Increased lower facial height
      - Large interlabial gap
      - Ideal upper lip–maxillary incisor relationship (3-mm incisor exposure)

Problem list

1. Anterior open bite
2. Increased interlabial gap
3. Mandibular anteroposterior deficiency
4. Maxillary transverse deficiency
5. Posterior maxillary vertical excess
6. Broken-down left mandibular first molar
7. Maxillary dental protrusion

Presurgical orthodontics

- Maxillary arch (Fig 4-91)
  - Alignment of the maxillary arch in three segments, from the right second premolar to the right second molar, the right canine to the left canine, and the left second premolar to the left second molar.
  - Extraction of both first premolars at the time of surgery to allow ideal surgical positioning of the anterior maxillary segment.
  - Deviation of the roots of both canines and both second premolars to allow surgical closure of the extraction spaces of both first premolars.
- Mandibular arch (see Fig 4-91)
  - Extraction of the left mandibular first molar.

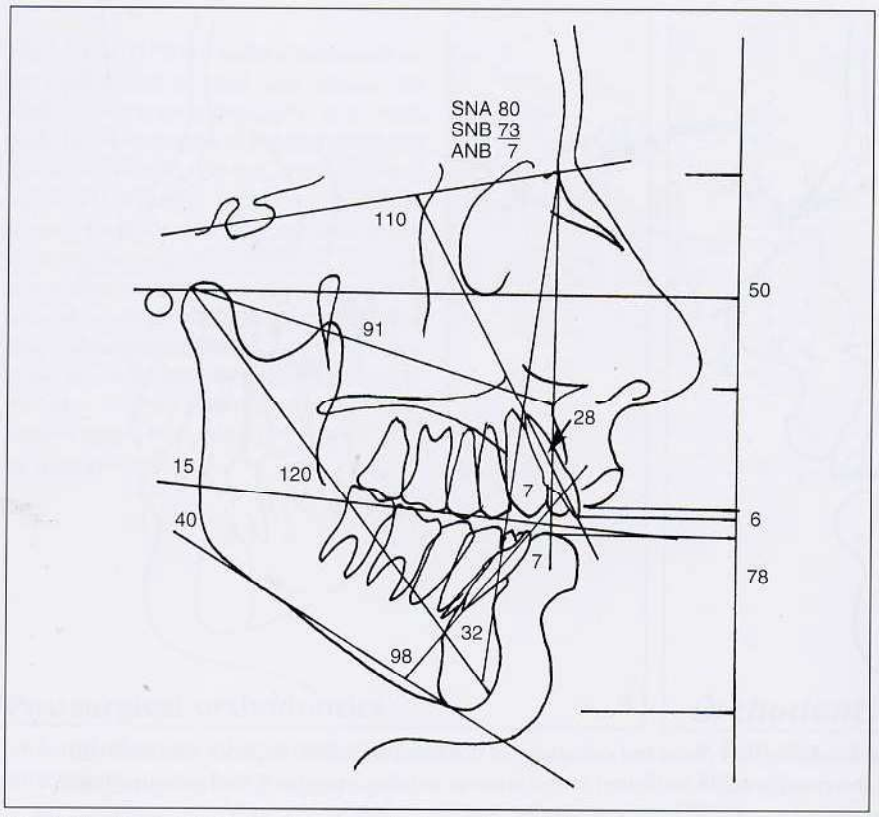


Fig 4-90 Case K.P. Pretreatment cephalometric analysis. Class II occlusion; anterior open bite; increased interlabial gap: 6 mm; increased lower facial height: middle third to lower third = 50:78 mm; mandibular anteroposterior deficiency: SNB = 73 degrees; increased mandibular plane angle: 40 degrees; maxillary incisor protrusion: maxillary incisor to S-N = 110 degrees, maxillary incisor to N-A = 28 degrees and 7 mm. The maxillary incisor–upper lip relationship is good (1.5-mm tooth exposure); it is important to maintain this relationship during treatment.

Fig 4-91 Case K.P. Immediate presurgical occlusion. Note the segmental orthodontic alignment of the maxillary arch. The first premolars are not banded and will be extracted at surgery.

- Closure of the space where the left first molar was extracted.
- Leveling and alignment of the arch.

Surgical treatment

- Extraction of both maxillary first premolars (Fig 4-92).
- Performance of a three-piece Le Fort I osteotomy with the interdental osteotomy through the extraction sites of the maxillary first premolars. Removal of bone in the extraction spaces allowed surgical closure of the spaces, and a palatal osteotomy allowed expansion of the posterior segments (see Fig 4-92).
- Repositioning of the anterior maxillary segment. This was critical in two respects:
  1. The vertical upper lip–maxillary incisor relationship had to be maintained.
  2. The segment could not be retracted excessively, as that would undermine lip support and increase the labiomental angle.
- Superior repositioning of the posterior segment to allow the mandible to autorotate (see Fig 4-92).
- Advancement of the mandible by means of a bilateral split osteotomy (see Fig 4-92).

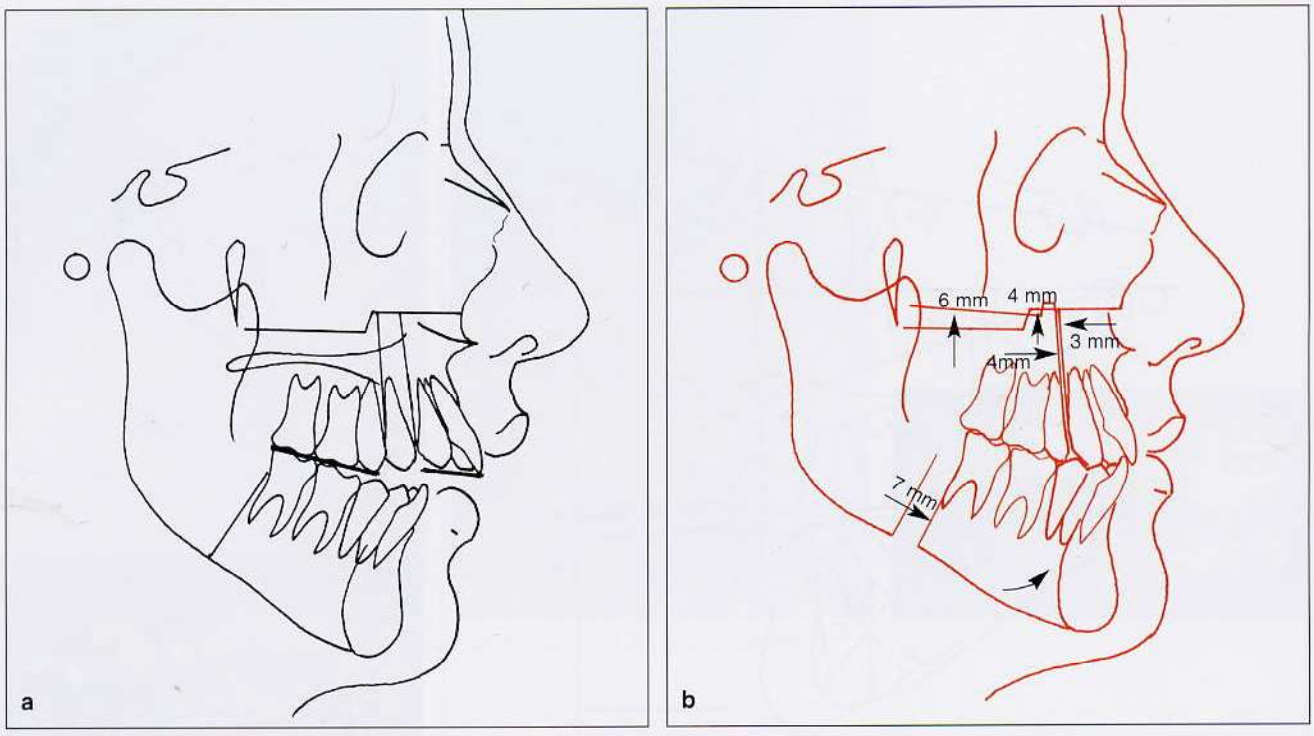


Fig 4-92 Case K.P. *(a)* Immediate presurgical tracing that plans the extraction of the first premolars, superior repositioning of the posterior maxillary segments, expansion of the maxilla, slight retraction of the anterior maxillary segment, and advancement of the mandible. *(b)* The predicted postsurgical result.

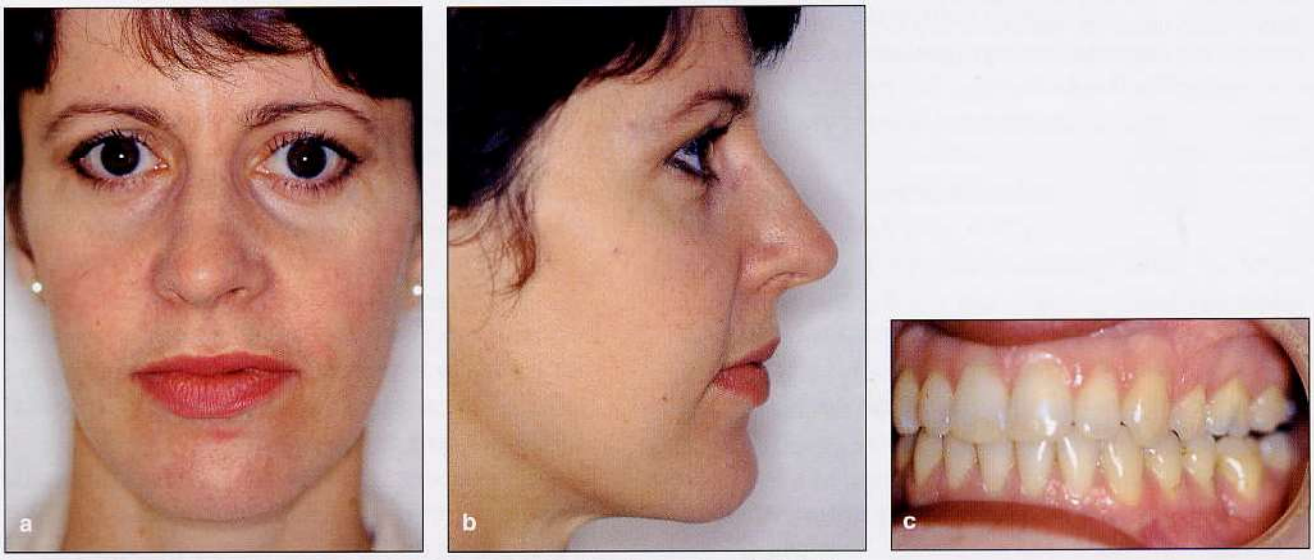


Fig 4-93 Case K.P. Posttreatment frontal view *(a)*, profile view *(b)*, and occlusion *(c)*.

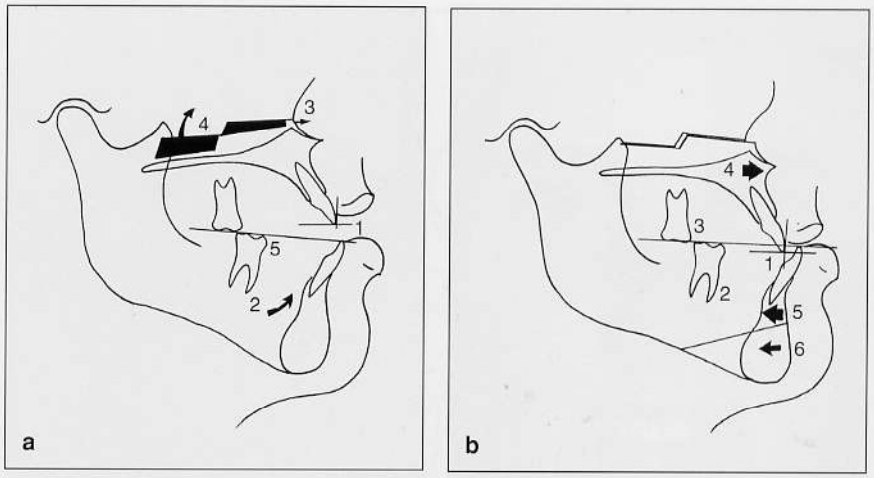


Fig 4-94 *(a)* (1) The maxillary incisor–upper lip relationship is ideal and should be maintained anteroposteriorly and vertically. (2) Autorotation of the mandible. (3) Forward rotation of the anterior nasal spine. (4) Superior repositioning of the posterior maxilla. (5) Final occlusal plane determined by the mandibular occlusal plane after rotation. *(b)* (1) Ideal maxillary incisor–upper lip relationship. (2) Mandible has autorotated. (3) Occlusion is more Class III with an anterior crossbite. Options include maxillary advancement (4), mandibular setback (5), both options 4 and 5, or genioplasty (6).

Postsurgical orthodontics

- Final closure of extraction spaces
- Finalization of the occlusion
- Retention

Closure of the extraction space of the mandibular left first molar prolonged the orthodontic preparation, and surgery was performed 25 months after commencement of orthodontic treatment. The orthodontic bands were removed 9 months after surgery. The 2-year postsurgical results are illustrated in Fig 4-93.

Class III open bite

Clinical characteristics

1. Mandibular anteroposterior excess (magnitude of the anteroposterior discrepancy masked by backward rotation of the mandible).
2. Maxillary vertical excess (more posterior than anterior).
3. Transverse maxillary deficiency.
4. Posterior crossbites.
5. Class III malocclusion.
6. Often, a reverse curve of Spee.
7. Increased mandibular plane angle.
8. Clockwise rotation of the mandible makes the Class III relationship better; vertical correction will make the Class III relationship worse.

Orthodontic preparation

- Remove any existing dental compensation.
- Where segmental surgery is contemplated, align the maxillary arch in segments, and deviate roots at interdental osteotomy areas.
- Level and align the mandibular arch.

Surgical solutions

Following are surgical solutions to Class III open bite (Fig 4-94):

- One-piece Le Fort I osteotomy with superior repositioning of the maxilla (more posterior than anterior) to achieve the ideal maxillary incisor–upper lip relationship
- Segmental surgery with differential superior repositioning of the maxilla (the posterior segments more superiorly than the anterior segment)
- Expansion of the buccal segments
- Mandibular setback
- Genioplasty

Comments on Class III open bite

Inferior repositioning of the anterior maxilla and superior repositioning of the posterior maxilla are often indicated. The anterior maxilla often may be vertically deficient in Class

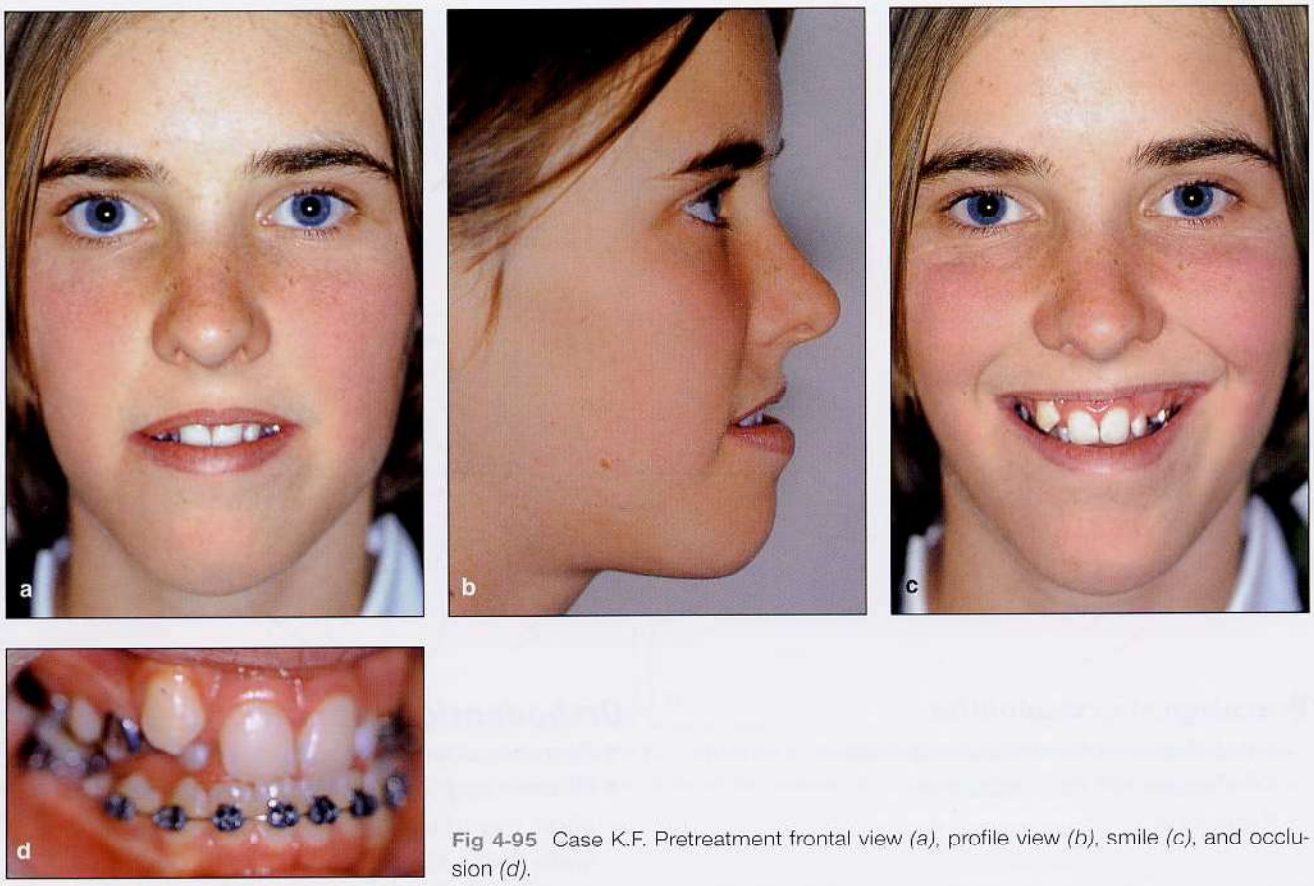


Fig 4-95 Case K.F. Pretreatment frontal view *(a)*, profile view *(b)*, smile *(c)*, and occlusion *(d)*.

III open bite cases, and the maxillary tooth-lip relationship is an important consideration in planning the final vertical position of the maxilla.

The mandible will autorotate, and the Class III occlusal relationship will worsen.

The anteroposterior discrepancy can be corrected by advancement of the maxilla, mandibular setback, both maxillary advancement and mandibular setback, and/or genioplasty. The treatment of choice depends on the esthetic requirements of the case.

Before treatment planning, the cause of the open bite should be determined. Open bites may develop because of:

1. Deficient eruption of maxillary incisors (anterior)
2. Deficient eruption of mandibular incisors (anterior)
3. Deficient eruption of maxillary and/or mandibular molars (posterior)
4. Excessive vertical development of the posterior maxilla

The key element of the analyses is evaluation of the vertical relationship of the maxillary incisors to the relaxed upper lip (keep lip length in mind). Deficient eruption of mandibular incisors with a reverse curve of Spee is often due to an abnormal size and resting posture of the tongue.

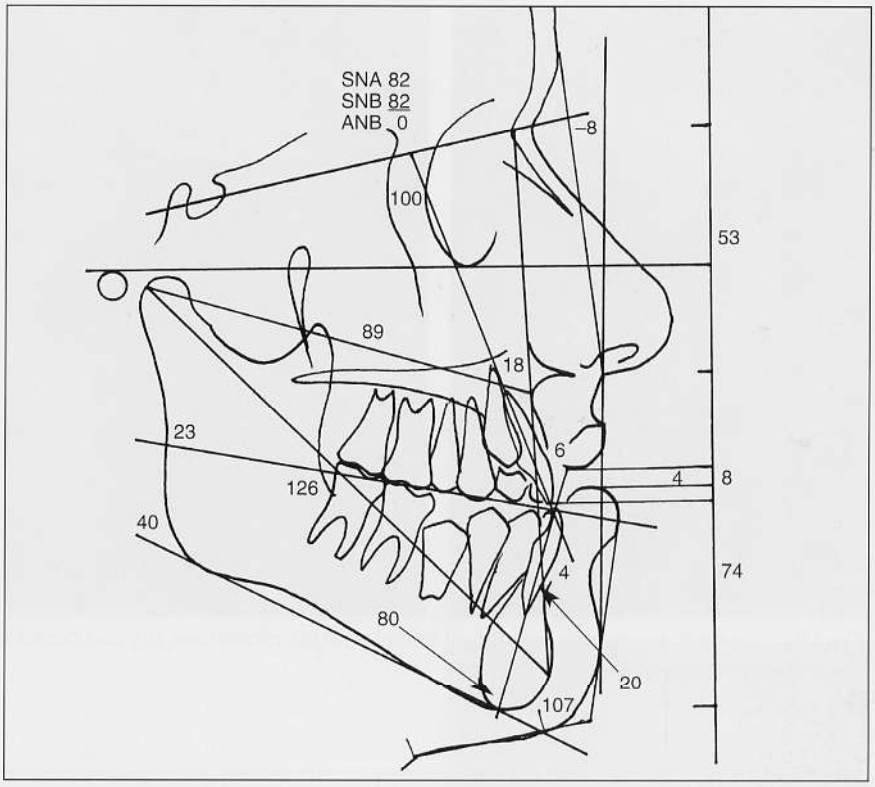


Fig 4-96 Case K.F. Pretreatment cephalometric analysis. Increased lower facial height: middle to lower facial height = 53:74 mm; maxillary-mandibular discrepancy in length: maxilla to mandible = 89:126 mm; mandibular anteroposterior excess: SNB = 82 degrees, ANB = 0 degrees; mandibular incisor compensated: mandibular incisor to mandibular plane = 80 degrees, mandibular incisor to N-B = 20 degrees.

Posterior open bites can develop in three ways:

1. Excessive vertical development on one side, often associated with facial asymmetry (eg, unilateral condylar hyperplasia)
2. Deficient eruption of teeth on one side (eg, impacted teeth), with normal symmetry
3. Bilateral deficient eruption of posterior teeth (eg, cleidocranial dysostosis or large tongue) with normal symmetry

Figures 4-95 to 4-99 demonstrate the correction of a Class III anterior open bite in a 15-year-old female patient (Case K.F.). Superior repositioning of her maxilla to facilitate autorotation of the mandible and correction of the open bite worsened the Class III relationship, which necessitated mandibular setback.

Maxillary expansion

The transverse dimension of the maxilla can be increased in four ways: *(1)* orthodontically, through dental tipping (torquing); *(2)* by rapid palatal expansion (in growing individuals); *(3)* through surgically assisted palatal expansion (in nongrowing individuals); and *(4)* through surgical expansion.

Dental tipping

Dental tipping is indicated where the skeletal base width is adequate and where the required transverse arch dimension can be achieved by moving the teeth buccally by orthodontic force.

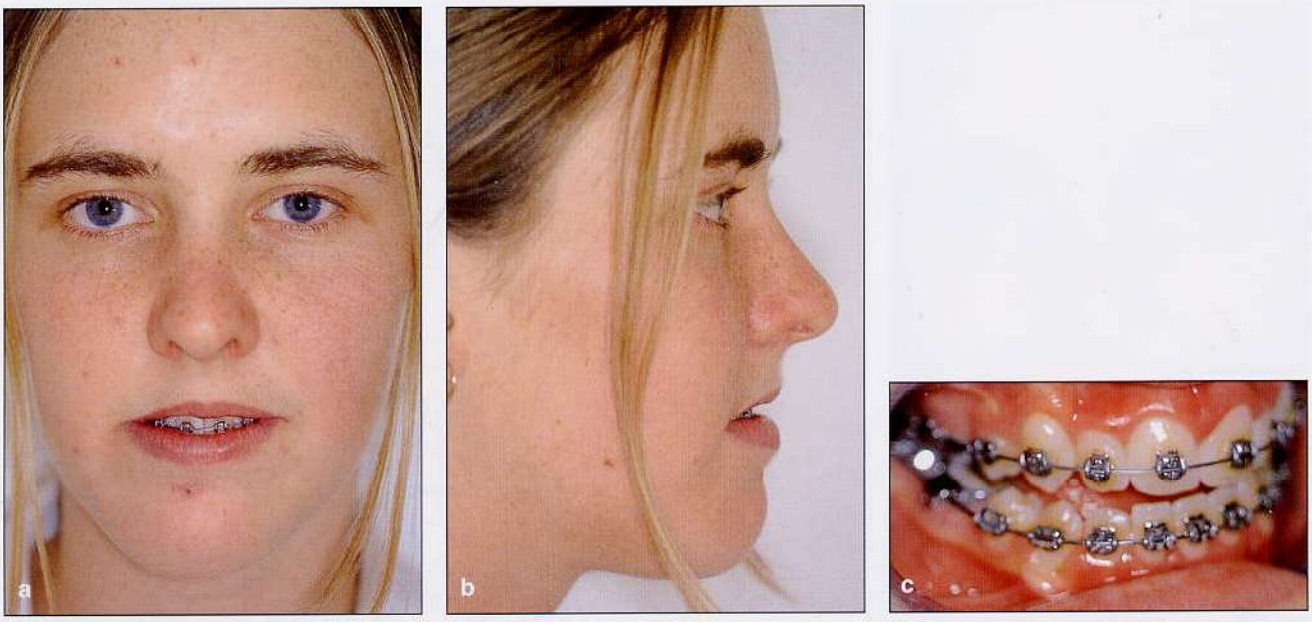


Fig 4-97 Case K.F. Immediate presurgical frontal view *(a)*, profile view *(b)*, and occlusion *(c)*. Note the worsening of the asymmetry and Class III dental relationship.

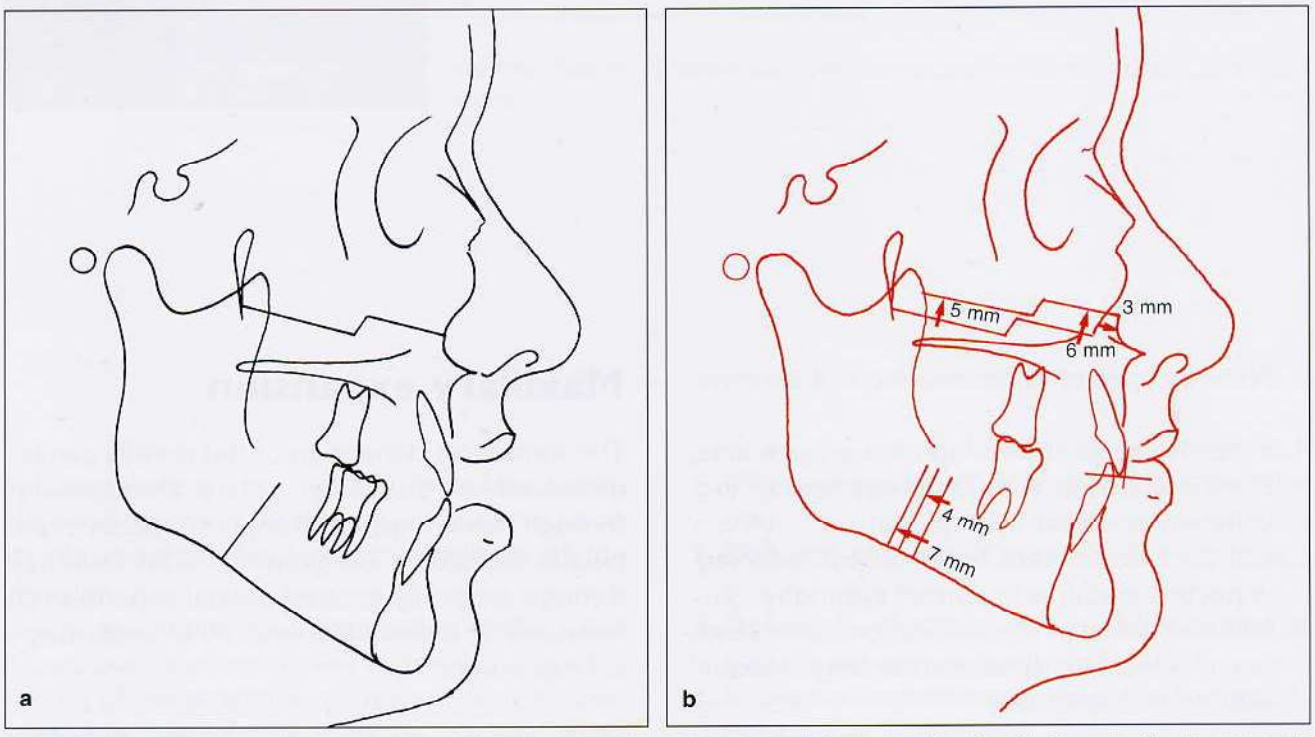


Fig 4-98 Case K.F. Presurgical cephalometric tracing *(a)* and the surgical visual treatment objective *(b)*. The maxilla will be superiorly repositioned by 6 mm anteriorly and 5 mm posteriorly. The maxilla will be advanced by 3 mm at the same time. The mandible will be set back by 7 mm on the left side and 4 mm on the right side.

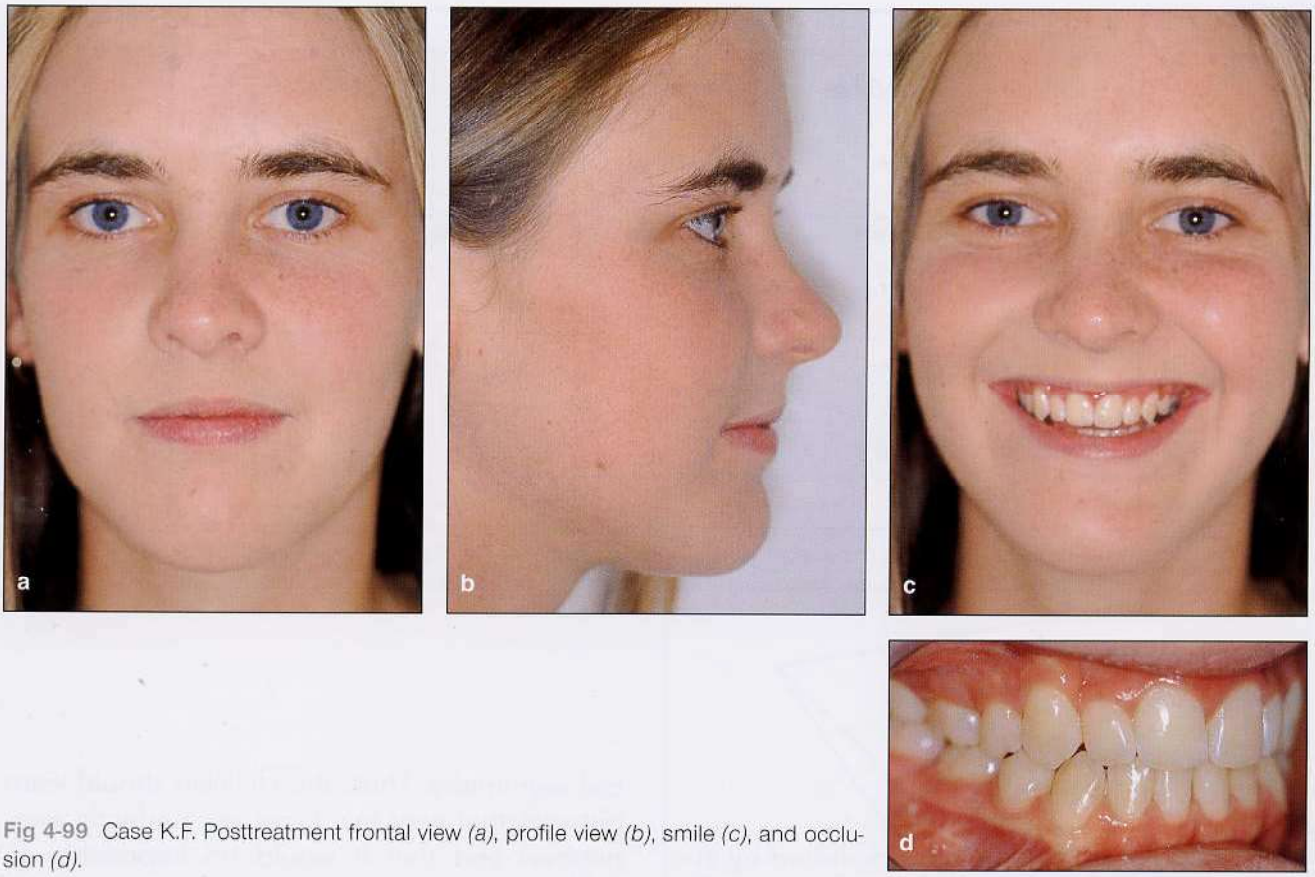


Fig 4-99 Case K.F. Posttreatment frontal view *(a)*, profile view *(b)*, smile *(c)*, and occlusion *(d)*.

Rapid palatal expansion

Rapid palatal expansion achieved by opening the midpalatal suture is indicated in young, growing individuals with narrow palatal vaults. An ideal patient for this form of expansion has a combination of transverse dental and skeletal deficiency because tooth movement is also produced by the force systems designed to open the suture. The expansion force has an age-dependent threshold; as a child matures, the resistance to suture separation increases. The ratio between sutural expansion and tooth movement is approximately 50:50. Depending on the bone-tooth relationship, between 40% and 60% of the distance gained by dental movement will be lost.

Surgically assisted palatal expansion

Surgically assisted palatal expansion is a form of distraction osteogenesis. This form of expansion is recommended in patients younger than 25 years who would not require any other orthognathic surgical procedures. The surgical technique involves reducing the skeletal resistance to orthodontic expansion by performing osteotomies at the lateral maxillary buttress and/or in the palate. Surgically assisted expansion is not recommended in patients older than 30 years because of the increased interdigitation of the remaining suture lines. The expansion appliance should remain in place at least 2 months after expansion has stopped, and a fixed retainer should remain in place after removal of the distraction device for another 6 to 12 weeks.

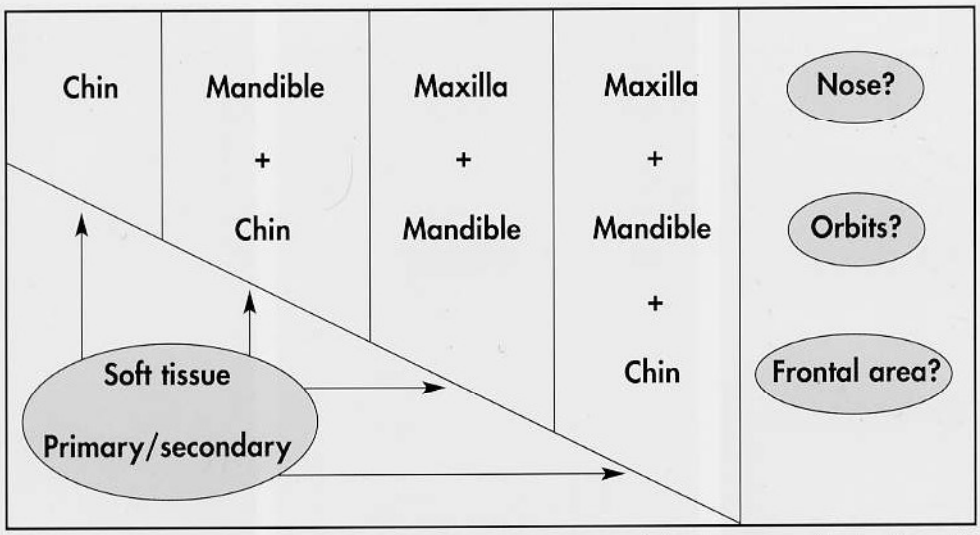


Fig 4-100 Categorization of possible facial asymmetry patterns. The diagram assists in differentiating between a specific area of asymmetry and a combination of areas influencing the symmetry of the face.

Surgical expansion

Surgical expansion can be accomplished by either posterior segmental osteotomies or a Le Fort I osteotomy, segmenting the maxilla in the down-fractured position. Where a large amount of expansion is required, bilateral palatal osteotomies should be performed. The osteotomy should be made just lateral to the nasal septum, where the palatal bone is thin and the mucosa thick. Soft tissue release may be helpful for large expansion and should be performed off the osteotomy line. Grafting and appropriate rigid fixation should be used in palatal expansions of more than 3 mm. Postsurgical orthodontic control of the expanded segments is paramount for optimal postsurgical stability.

Dentofacial Asymmetry

Very few faces are perfectly symmetrical. Mild asymmetries of the dental arches and other facial structures are common and often clinically and functionally insignificant. Slight asymmetry of the face is often of little importance to patients, but some are very sensitive regarding facial asymmetry. Thus, the clinician should warn patients that very few faces are perfectly symmetrical and that it would be impossible to achieve perfect facial symmetry with treatment.

The many causes of facial asymmetry can be classified as congenital, developmental, posttraumatic, or the result of pathology. Some of the more common abnormalities affecting the face and leading to asymmetry are unilateral condylar hyperplasia, hemifacial microsomia, temporomandibular joint ankylosis, and deformities induced by trauma.

Like all orthognathic patients, individuals with facial asymmetry require a systematic and comprehensive examination, diagnosis, and treatment planning, as discussed in chapter 2. During the examination the clinician should pay special attention to three important factors: the location of the asymmetry, the tissues involved, and the dimensions involved.

The asymmetry of the face may be in the chin, mandible, maxilla, nose, orbits, zygoma, frontal areas, or a combination of these structures. Figure 4-100 presents a way to categorize facial symmetry patterns. The diagram should also assist the clinician in differentiating between the specific area and combination of areas of asymmetry. The involvement of other

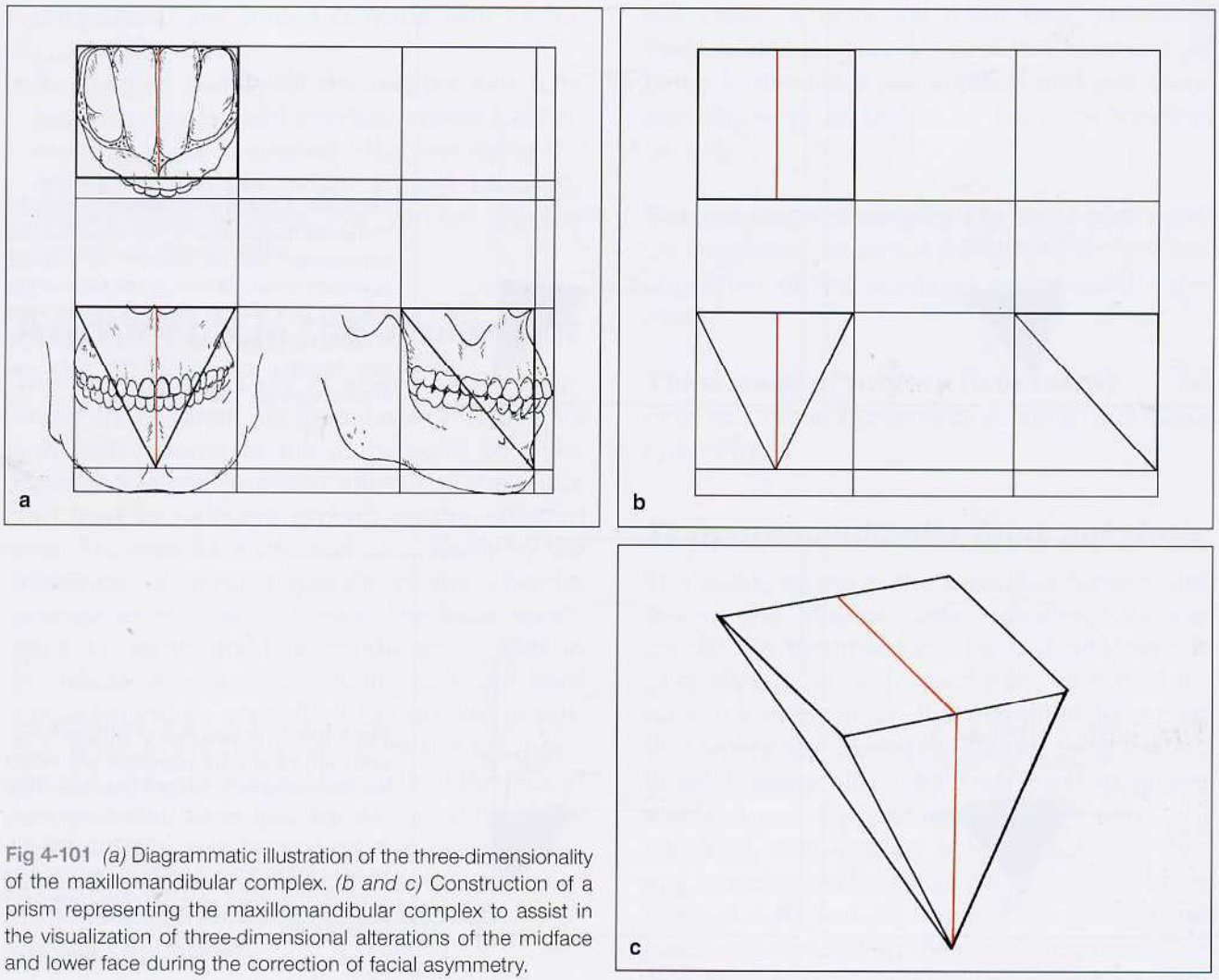


Fig 4-101 *(a)* Diagrammatic illustration of the three-dimensionality of the maxillomandibular complex. *(b and c)* Construction of a prism representing the maxillomandibular complex to assist in the visualization of three-dimensional alterations of the midface and lower face during the correction of facial asymmetry.

facial structures, ie, the nose, orbits, and frontal bone, should be considered, and the soft tissue involvement either primary or secondary to the skeletal asymmetry evaluated.

The clinician should determine what tissues are causing the asymmetry and whether the involvement is primary or secondary. This information will influence the treatment plan. For example, soft tissue asymmetry caused by mandibular asymmetry will be corrected by the skeletal correction, while the soft tissue deformity seen in hemifacial microsomia often requires further attention.

The dimensions involved in the asymmetry also should be determined. The maxillomandibular complex is a three-dimensional structure, as illustrated in Fig 4-101a. To simplify the determination of the three-dimensional skeletal, dental, and soft tissue alteration required for the correction of dentofacial asymmetries, a prism can be constructed to represent the maxillomandibular complex (Fig 4-101b). The prism helps the clinician visualize and evaluate the various three-dimensional surgical movements (Fig 4-101c). Figure 4-102 shows the effect of unilateral condylar hyperplasia on the spatial position of the prism. The opposite effect is demonstrated in Fig 4-103.

In the above cases, where facial asymmetry involves three dimensions, the transverse cant

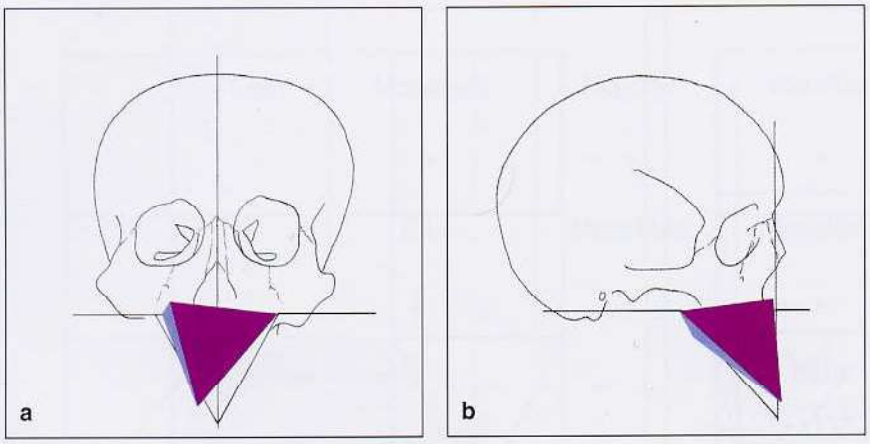


Fig 4-102 Unilateral increase in the height of the left mandibular ramus (eg, condylar hyperplasia) will be followed by the left posterior maxilla. A cant of the base of the "prism" will develop (more posterior than anterior), and the apex of the prism will rotate forward and toward the right. *(a)* Frontal view. *(b)* Lateral view.

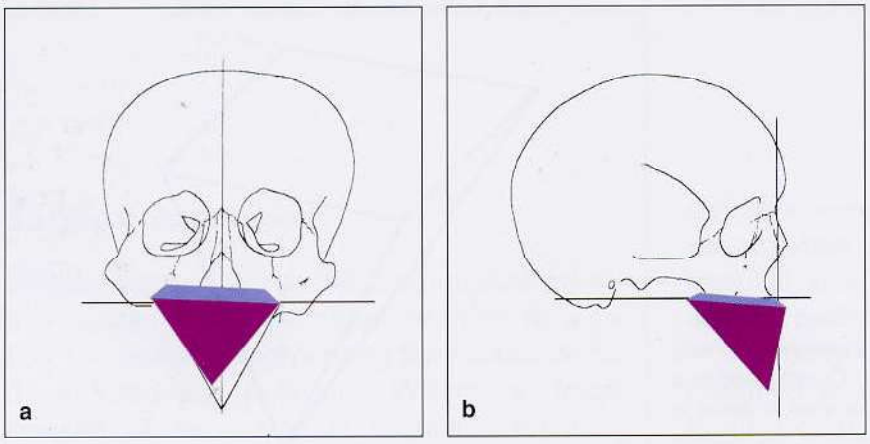


Fig 4-103 Unilateral lack of vertical development of the right mandible will inhibit vertical growth of the right posterior maxilla. The base of the "prism" will cant (more posterior than anterior), and the apex of the prism will rotate backward and toward the right. *(a)* Frontal view. *(b)* Lateral view.

of the occlusal plane obviously differs from anterior to posterior. Three-dimensional deformities can be best assessed by combining the data from the lateral, basal, and anteroposterior cephalometric radiographs with articulated dental casts (recorded with a facebow and articulated on an adjustable articulator) and clinical observations. As in the correction of other dentofacial deformities, the anteroposterior vertical and transverse positions of the maxillary incisors play an extremely important role in the final treatment planning (see chapter 2).

Neither presurgical nor postsurgical orthodontic treatment differs significantly from the orthodontic treatment in other dentofacial deformities. However, the clinician should consider the following guidelines for presurgical orthodontic treatment in cases with facial asymmetry:

- As in the previously discussed cases of dentofacial deformities, the dentition should not be orthodontically compensated for skeletal disharmony.
- An existing cant of the occlusal plane should not be corrected. The dental arch, however, should be leveled, and the orthodontist should ensure that the apical base midline and incisor midlines follow the cant.
- When skeletal asymmetry exists, the dental midlines should not be made to coincide but rather positioned in the midline of each jaw.
- Where facial asymmetry will be corrected by single-jaw surgery, the dental midline of the

unoperated jaw should coincide with the facial midline.
- In cases of hemifacial microsomia and temporomandibular joint ankylosis where a unilateral open bite is created after increasing the ramus height, the height should be maintained while allowing the vertical alveolar growth of the maxilla.

Asymmetry in the adolescent

The two major causes of severe facial asymmetry in children are hemifacial microsomia and early trauma to the mandibular condyle. Both conditions primarily affect the mandible and lead to deficient growth on the affected side. The maxilla is affected secondarily by the inhibition of vertical growth of the alveolar process on the affected side. The basic difference between the two conditions is that in hemifacial microsomia, missing soft and hard tissue structures may affect the growth potential, while in ankylosis, all structures are present but underdeveloped because of the lack of function. The basic principle in treating these conditions is to restore and maximize the expression of growth so that the development of both hard and soft tissue structures can be as normal as possible.

Hemifacial microsomia

The severity of this deformity varies widely. Both jaws and soft tissue in all three dimensions may be underdeveloped or missing. The surgical treatment can be divided into three stages.

First stage of surgery (5 to 7 years old)
In cases where the condyle is present but underdeveloped, it is better to accept the articulation regardless of the morphology. Distraction osteogenesis may be considered in these patients. When the proximal part of the mandible is missing, the missing elements should be reconstructed at this stage. To correct the vertical and anteroposterior dimension, the condyle can be reconstructed by a costochondral graft; this will create a unilateral open bite. Functional therapy after surgery is mandatory for these patients to stimulate jaw function and soft tissue development, as well as to minimize maxillary canting.

Second stage of surgery (14 to 16 years old)
Orthognathic surgery is performed for the final correction of the occlusion and skeletal asymmetry.

Third stage of surgery (late teens)
Final soft tissue procedures establish soft tissue symmetry.

Temporomandibular joint ankylosis

The ability to move the mandible forward and toward the affected side indicates how successful the treatment will be and whether surgery should be performed early or not. If the patient cannot move the mandible to a position where the dental midlines coincide, functional therapy alone will not result in growth modification. Early surgery that releases the ankylosis, followed by active functional therapy, is indicated for these patients. Surgical release should include removal of all soft and hard tissue (including the coronoid process), as well as mandible release. This may be technically difficult. It is futile to perform the above procedure without physical therapy to maintain the mouth opening obtained at surgery; either the joint will reankylose or soft tissue scarring will limit mouth opening. The surgical treatment for patients with ankylosis can be performed in two stages.

First stage of surgery (5 to 7 years old)
The first stage is surgical release of the ankylosis, followed by long-term physical therapy. A costochondral graft may be indicated to reconstruct the temporomandibular joint and correct the vertical and anteroposterior dimensions of the mandible on the affected side. This will create an open bite, which will allow vertical maxillary growth under orthodontic control.

Fig 4-104 Case R.C. Pretreatment frontal view *(a)*, profile view *(b)*, and right side of the occlusion *(c)*. The presurgical occlusion *(d)* and maximal mouth opening before surgery *(e)* also are shown.

Second stage of surgery (14 to 16 years old)
The second surgical stage involves the final correction of facial asymmetry and occlusal cants by means of orthognathic surgery.

Case R.C.

Case R.C. was a patient who developed ankylosis of her temporomandibular joint after trauma to her chin at 3 years of age. When her orthodontist saw her at the age of 6, she had a severe malocclusion and a maximum mouth opening of 1 mm. Her parents recalled that she had fallen on her chin in a park when she was 3 years old. Although she experienced some pain at the time, she recovered uneventfully.

Main complaint
The patient's main concerns were limited mouth opening, an inability to eat properly, and a "crooked" face.

Medical history
The patient's medical history was noncontributory.

Clinical examination
1. Soft tissue
   a. Frontal view (Fig 4-104a)
      - Severe asymmetry of the mandible toward the left side
      - Everted lower lip
      - Flat appearance of the right side of the chin and mandible

- Excessively rounded appearance of the left side of the mandible

b. Profile view (Fig 4-104b)
- Mandibular anteroposterior deficiency
- Microgenia
- Everted lower lip
- Increased interlabial gap

2. Dental (Figs 4-104c and 4-104d)
- Class II malocclusion, more on the left side
- Increased overjet
- Crowding in the maxillary and mandibular arches
- Mandibular dental midline toward the left
- Maximal mouth opening of 1 mm (Fig 4-104e)

3. Skeletal
- Mandibular anteroposterior deficiency
- Microgenia
- Mandibular asymmetry toward the left
- Ankylosis of the left temporomandibular joint

4. Radiographic

a. Panoramic radiograph (Fig 4-105a)
- A large, bony mass in the left temporomandibular joint area
- An elongated coronoid process

b. Lateral cephalometric (Fig 4-105b)
- Severe mandibular anteroposterior deficiency

c. Anteroposterior cephalometric (Fig 4-105c)
- Severe asymmetry of the mandible toward the left
- Transverse cant of the occlusal plane

Problem list

1. Ankylosis of the left temporomandibular joint
2. Deficiency of the left side of the mandible
3. Mouth opening of 1 mm
4. Slight cant in the maxillary occlusal plane due to deficient vertical growth of the maxilla on the left
5. Class II malocclusion

Treatment plan

1. Surgical removal of bony ankylosis and creation of an articular fossa (Figs 4-106a and 4-106b)
2. Surgical removal of scar tissue that may inhibit normal mouth opening
3. Coronoidectomy of the left coronoid process (see Figs 4-106a and 4-106b)
4. Harvesting of a costochondral graft from the left eighth rib
5. Placement of a costochondral graft to reconstruct the left temporomandibular joint (Figs 4-106c and 4-106d)
6. Physical therapy to maintain the mouth opening achieved at surgery and establish function to encourage growth of the deficient hard and soft tissues
7. Continuation of the orthodontic treatment to establish normal occlusion

Presurgical orthodontics

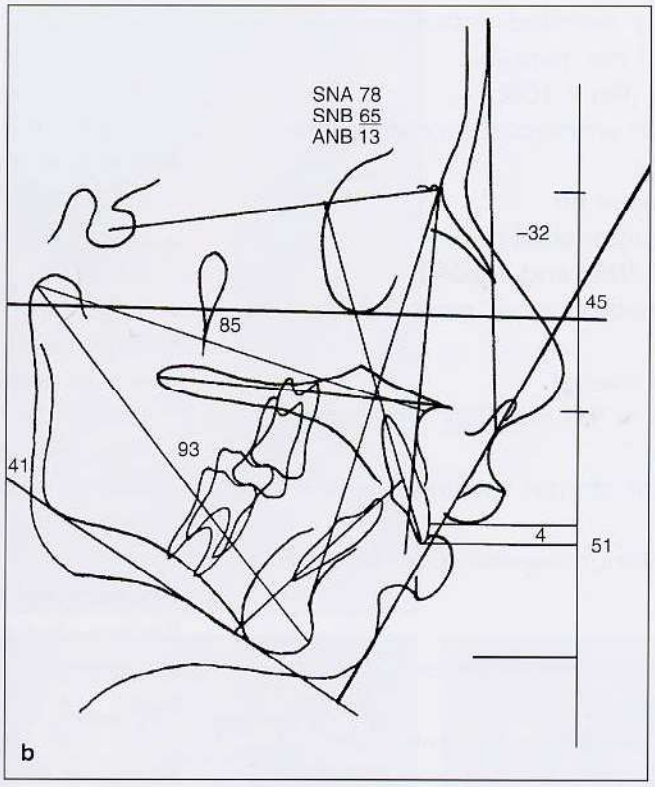
Because the patient could not open her mouth, the presurgical orthodontic treatment was limited.

Surgical treatment

- The left temporomandibular joint was reconstructed by means of a costochondral graft, and a mouth opening of 35 mm was achieved at surgery.
- A gap was created between the maxillary and mandibular teeth on the left and was maintained by means of a splint (Figs 4-107a and 4-107b).
- A coronoidectomy was performed on the left side.
- The patient followed an active physical therapy program, assisted by a mouth-opening appliance placed at the time of surgery. Excellent patient cooperation led to a mouth opening of 33 mm after 1 year.

Postsurgical orthodontics

Postsurgical orthodontic treatment began only 6 months after surgery and was completed after 15 months. The postsurgical growth of the hard and soft tissue on the affected side and the final mouth opening are evident in Fig 4-108. It is again important to stress that the success of surgical treatment of temporomandibular ankylosis is dependent on diligent postsurgical physical therapy.



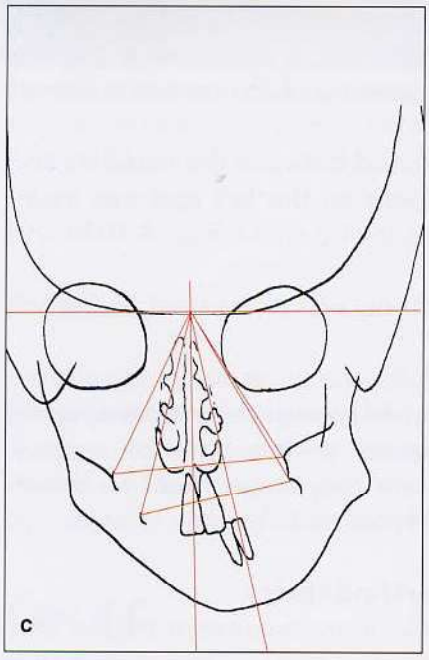


Fig 4-105 Case R.C. *(a)* Left side of the panoramic radiograph. The large bony mass obliterating the left temporomandibular joint *(black arrows)* and the elongated coronoid process *(white arrows)* are clearly visible. *(b)* The pretreatment lateral cephalometric tracing illustrating anteroposterior deficiency: SNB = 65 degrees, ANB = 13 degrees; convex profile: facial contour angle = −32 degrees; and the vertical difference of the left and right lower border of the mandible. *(c)* The presurgical anteroposterior cephalometric tracing clearly illustrates the severe asymmetry of the mandible. The transverse cant of the maxillary occlusion is only slightly affected at this stage and would probably respond favorably to functional correction of the mandible.

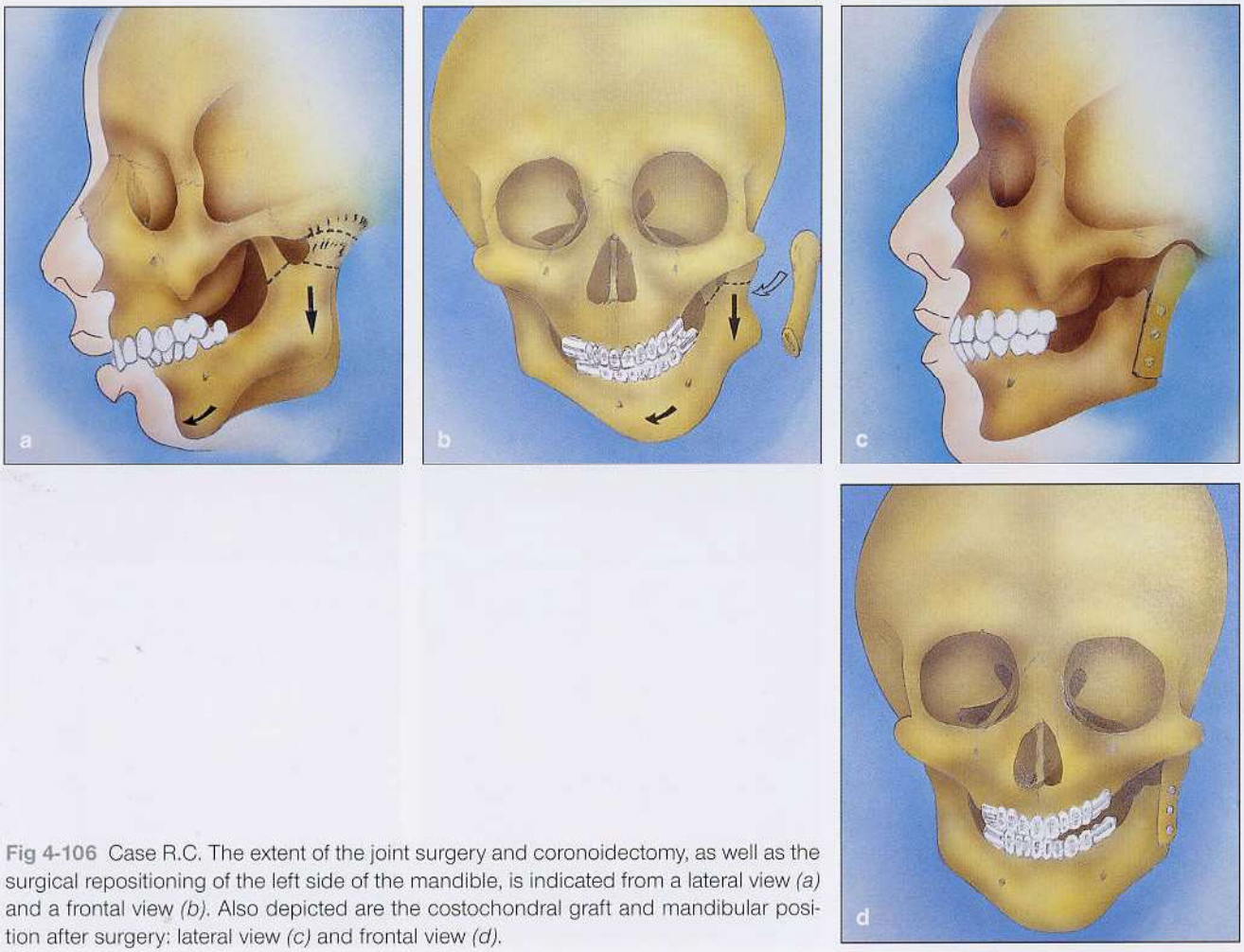


Fig 4-106 Case R.C. The extent of the joint surgery and coronoidectomy, as well as the surgical repositioning of the left side of the mandible, is indicated from a lateral view *(a)* and a frontal view *(b)*. Also depicted are the costochondral graft and mandibular position after surgery: lateral view *(c)* and frontal view *(d)*.

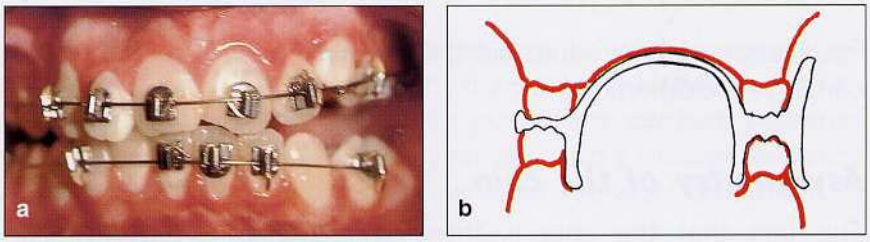


Fig 4-107 Case R.C. *(a)* The lateral open bite on the left was created by elongation of the left mandibular ramus by the rib graft. *(b)* The height of the left ramus is maintained by an acrylic splint placed at surgery.

Fig 4-108 Case R.C. Postsurgical frontal view *(a)* and profile view *(b)* demonstrate the soft and hard tissue response to normal jaw function. The postsurgical occlusion *(c)* and mouth opening of 33 mm *(d)* are shown 2 years after surgery.

Asymmetry in the adult

Facial asymmetry in adults will be discussed according to location.

Asymmetry of the chin

The fact that the chin is three-dimensional should always be considered during assessment and correction of the chin asymmetry.

Transverse asymmetry

Transverse asymmetry of the chin is corrected by a sliding genioplasty that repositions the chin toward the left or right side (Fig 4-109a).

Cant of the lower border of the chin

A cant of the lower border of the chin is corrected by vertical change at the osteotomy site. The vertical height can be unilaterally reduced or increased by either downgrafting one side or performing an ostectomy on the other (Fig 4-109b). An alternative is a propeller osteotomy (see chapter 5).

Anteroposterior asymmetry

Anteroposterior asymmetry can be corrected by differential anterior or posterior repositioning of the chin (Fig 4-109c).

Case O.A. demonstrates the correction of asymmetry of the chin in a transverse and vertical dimension (Fig 4-110).

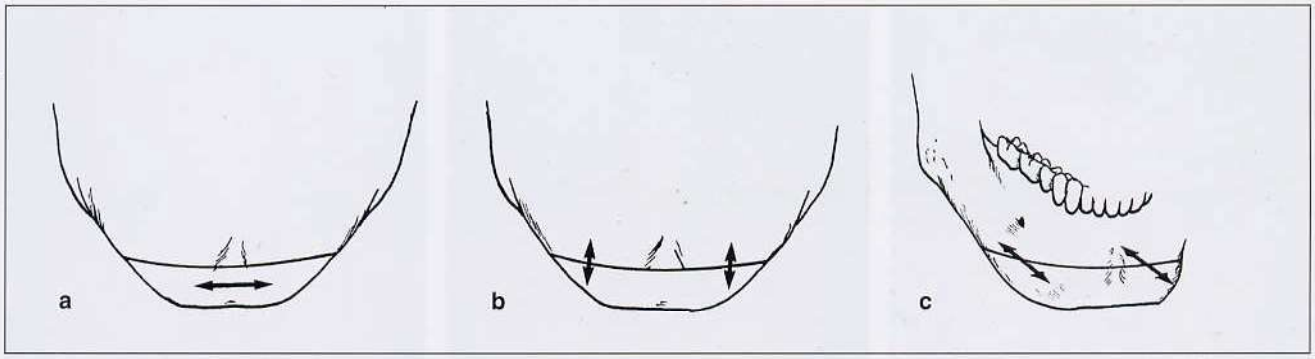


Fig 4-109 *(a)* Left or right sliding genioplasty for correction of transverse asymmetry of the chin. *(b)* Vertical reduction or downgraft of the chin to correct an asymmetrical cant of the lower border. *(c)* Differential anterior or posterior repositioning of the chin to correct anteroposterior asymmetries.

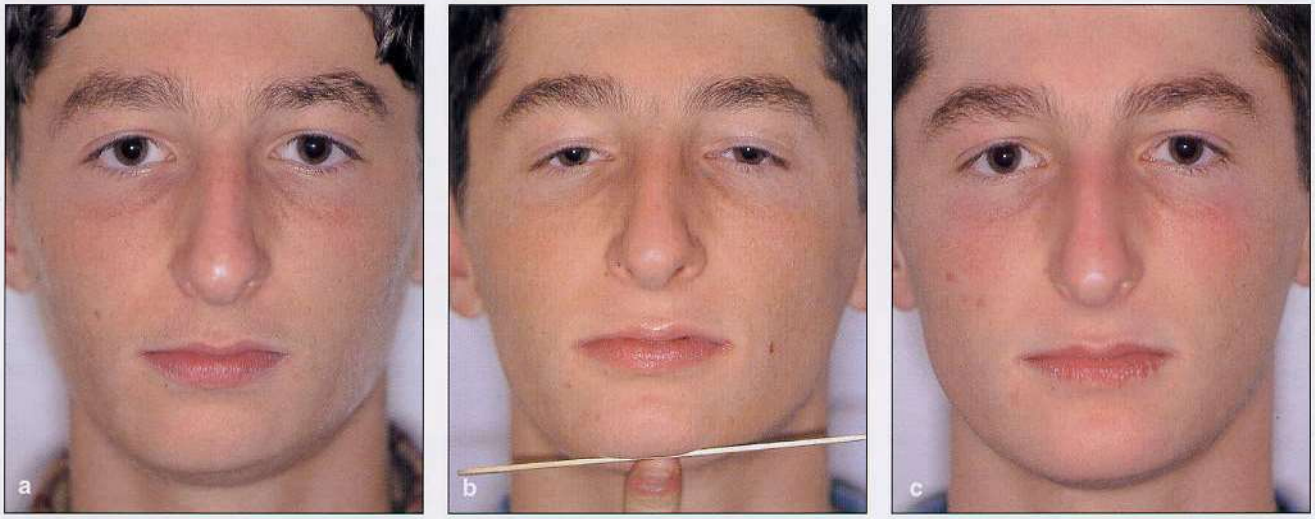


Fig 4-110 Case O.A. The transverse asymmetry of the chin toward the right *(a)* and the cant of the lower border of the chin *(b)* are evident. *(c)* A symmetrical chin has been established by means of a genioplasty, sliding the chin toward the left side and downgrafting it on the left.

Asymmetry of the mandible

Most patients with mandibular anteroposterior excess have some form of asymmetry. Facial asymmetry caused by mandibular asymmetry can be corrected by surgical repositioning of the mandible. It is important that the orthodontist position the lower incisors in the middle of the chin so that when the dental midlines are corrected, the middle of the chin is in the facial midline. The bilateral split ramus osteotomy is the procedure of choice for small corrections, whereas bilateral vertical osteotomies of the mandibular ramus are indicated for the correction of large asymmetries. When a bilateral sagittal split osteotomy is used to correct severe asymmetry, the proximal segments tend to flare, leading to poor bone contact, posterior mandibular asymmetry, and a greater tendency for peripheral condylar sag after placement of internal rigid fixation.

Case P.H. illustrates the correction of mandibular asymmetry. The mandible was asymmetrical toward the right, and there was mandibular anteroposterior excess (Fig 4-111). No attempt was made to correct the dental midlines during the preorthodontic preparation. The mandibular dental midline was positioned in the midline of the chin, while the maxillary incisor midline was positioned in the midline of

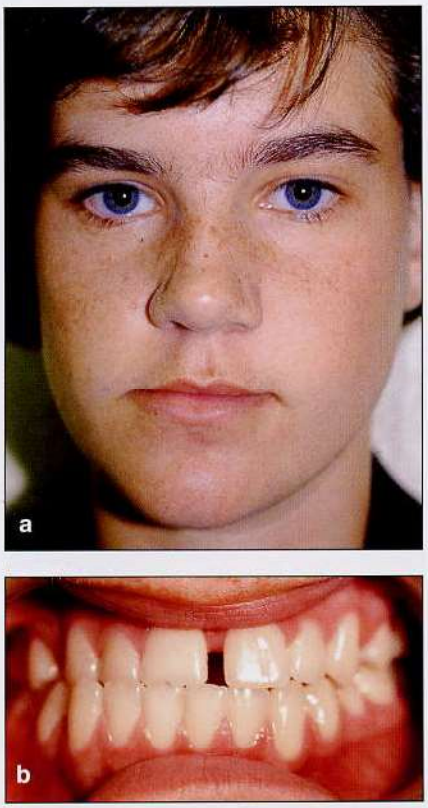


Fig 4-111 Case P.H. Facial asymmetry *(a)* and asymmetrical Class III malocclusion *(b)*.

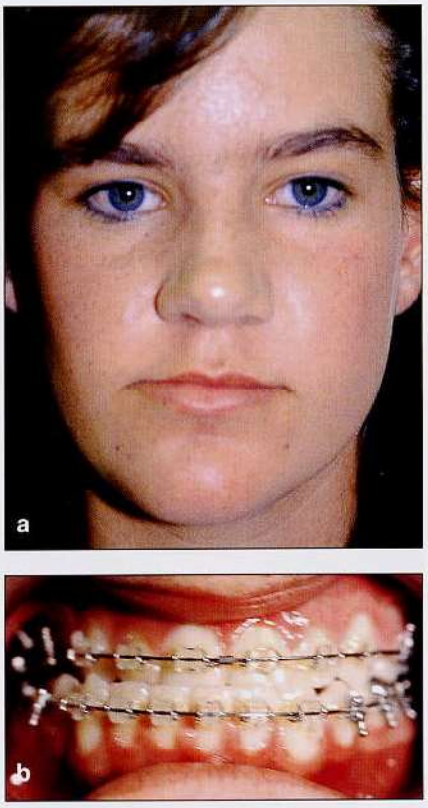


Fig 4-112 Case P.H. Slight worsening of the facial symmetry *(a)* and dental asymmetry after presurgical orthodontic treatment *(b)*.

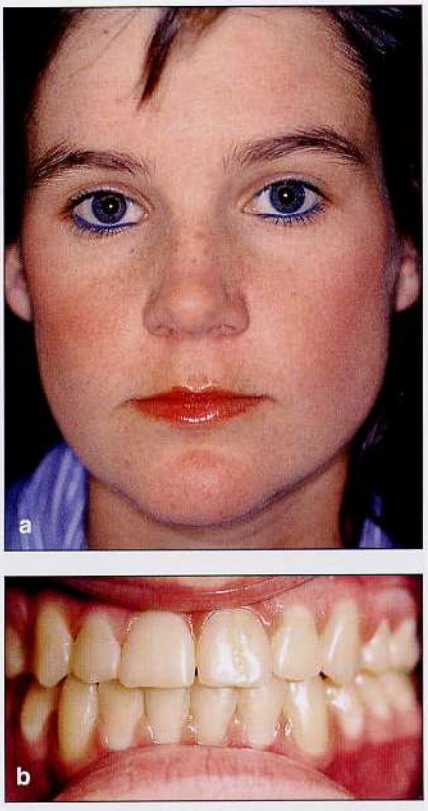


Fig 4-113 Case P.H. Posttreatment results are demonstrated in frontal view *(a)* and occlusion *(b)* 2 years after debanding.

the face (Fig 4-112). Facial and dental symmetry were established by a bilateral sagittal split ramus osteotomy. The treatment results 2 years after debanding are seen in Fig 4-113.

Asymmetry of the mandible and chin

Mandibular asymmetry often occurs in combination with chin asymmetry. When both kinds of asymmetry are present, the dental midline does not coincide with the midline of the chin. After surgical correction of the mandibular asymmetry with correction of the dental midline, additional correction of the chin midline will be necessary. Accurate presurgical assessment of dental and chin midlines in relation to the facial midline is essential. When facial asymmetry will be corrected by mandibular surgery, the orthodontist must ensure that the maxillary dental midline is corrected orthodontically before surgery.

Correction of a combination of mandibular and chin asymmetry is demonstrated in Case P.C. The patient's mandible was asymmetrical toward the right and anteroposteriorly deficient with a Class II malocclusion (more on the right side than the left side). The mandibular dental midline was 4 mm to the right of the maxillary incisor midline (facial midline); however, the midline of the chin was 11 mm to the right of the facial midline. There was a slight transverse cant in the maxillary occlusal plane, but it was not clinically significant (Fig 4-114). The mandibular asymmetry was corrected by a bilateral sagittal split ramus osteotomy, advancing the mandible and rotating it toward the left to correct the dental midlines. Final facial symmetry was established by a genioplasty, which slid the chin to the left, downgrafted it on the right, and reduced the chin height on the left. The treatment results are illustrated in Fig 4-115.

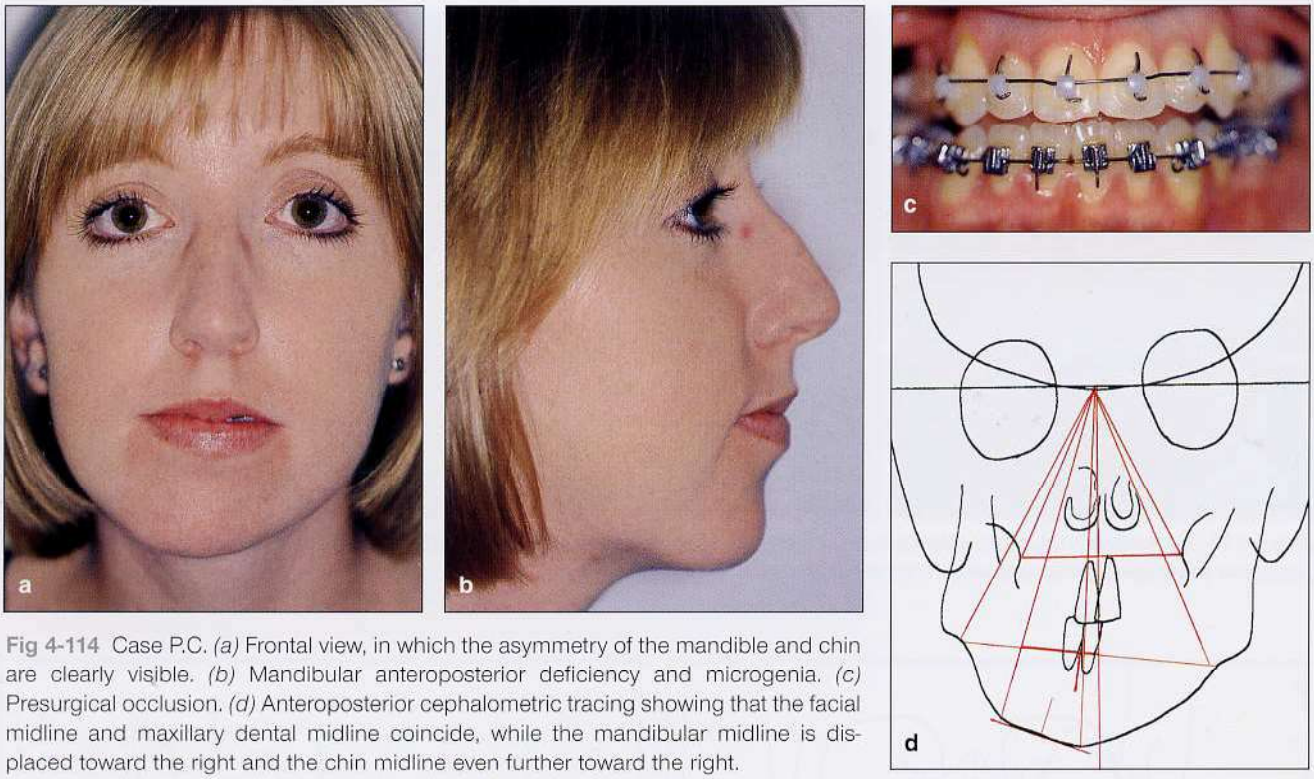


Fig 4-114 Case P.C. *(a)* Frontal view, in which the asymmetry of the mandible and chin are clearly visible. *(b)* Mandibular anteroposterior deficiency and microgenia. *(c)* Presurgical occlusion. *(d)* Anteroposterior cephalometric tracing showing that the facial midline and maxillary dental midline coincide, while the mandibular midline is displaced toward the right and the chin midline even further toward the right.

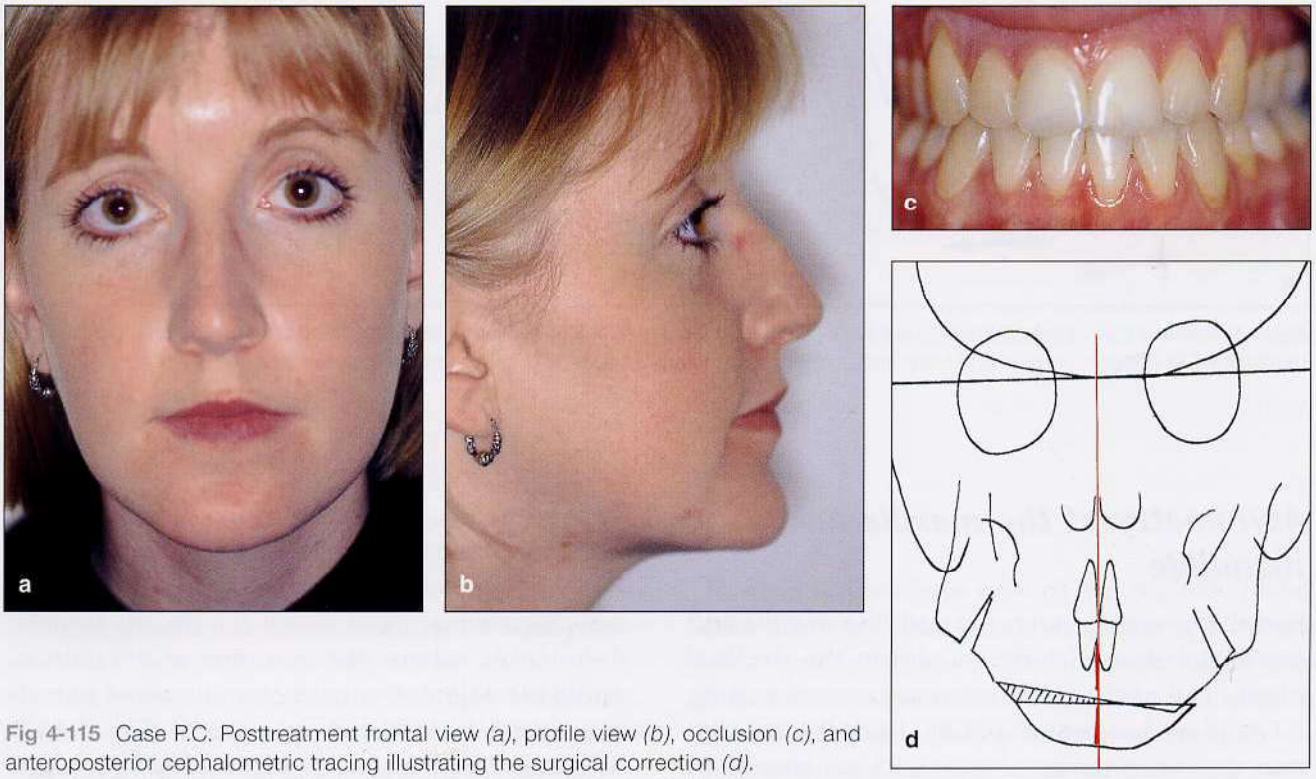


Fig 4-115 Case P.C. Posttreatment frontal view *(a)*, profile view *(b)*, occlusion *(c)*, and anteroposterior cephalometric tracing illustrating the surgical correction *(d)*.

Fig 4-116 Transverse cant of the anterior maxillary occlusal plane *(a)*, the lower border of the chin *(b)*, and the lower borders of the posterior mandible *(c)* are illustrated using a tongue spatula.

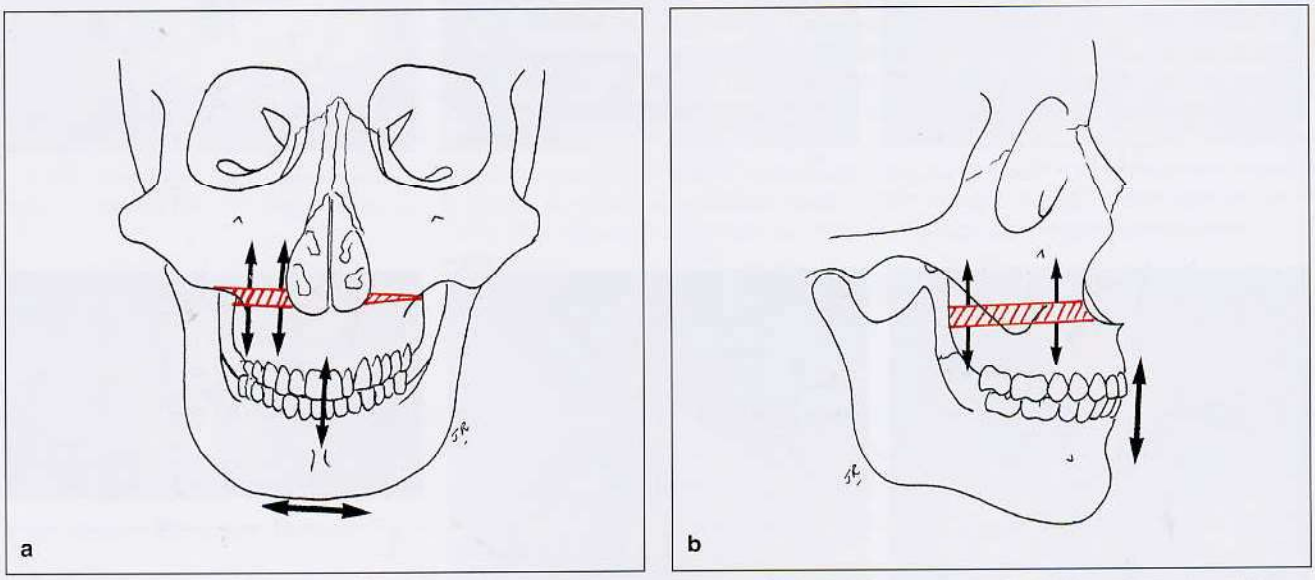


Fig 4-117 Correction of the cant of the occlusal plane in cases where the anterior and posterior cants are the same will involve two dimensions of change, vertical and transverse, as indicated by the *arrows* on the frontal view *(a)* and lateral view *(b)*.

Asymmetry of the maxilla and mandible

Facial asymmetry involving both the maxilla and mandible often includes a cant in the occlusal plane. The cant can be assessed clinically using a Fox plate or tongue spatula. Both the anterior and posterior cants of the occlusal plane, as well as the lower border of the mandible, should always be evaluated and noted (Fig 4-116). The cant in the occlusal plane of the maxilla is most easily and accurately evaluated on casts articulated on an adjustable articulator from a face-bow recording.

In cases where the anterior and posterior cants are equal, the correction involves two dimensions, transverse and vertical (Fig 4-117). The maxillary incisor–lip relationship is very important in the correction of the occlusal cant of the maxilla (see chapter 3).

Fig 4-118 The cant of the occlusal plane is demonstrated by the tongue spatula *(a)*, while the facial asymmetry involving the maxilla and mandible is seen in *(b)*. The postsurgical result after correction of the occlusal cant by means of a Le Fort I maxillary osteotomy and bilateral sagittal split ramus osteotomy is seen in *(c)*.

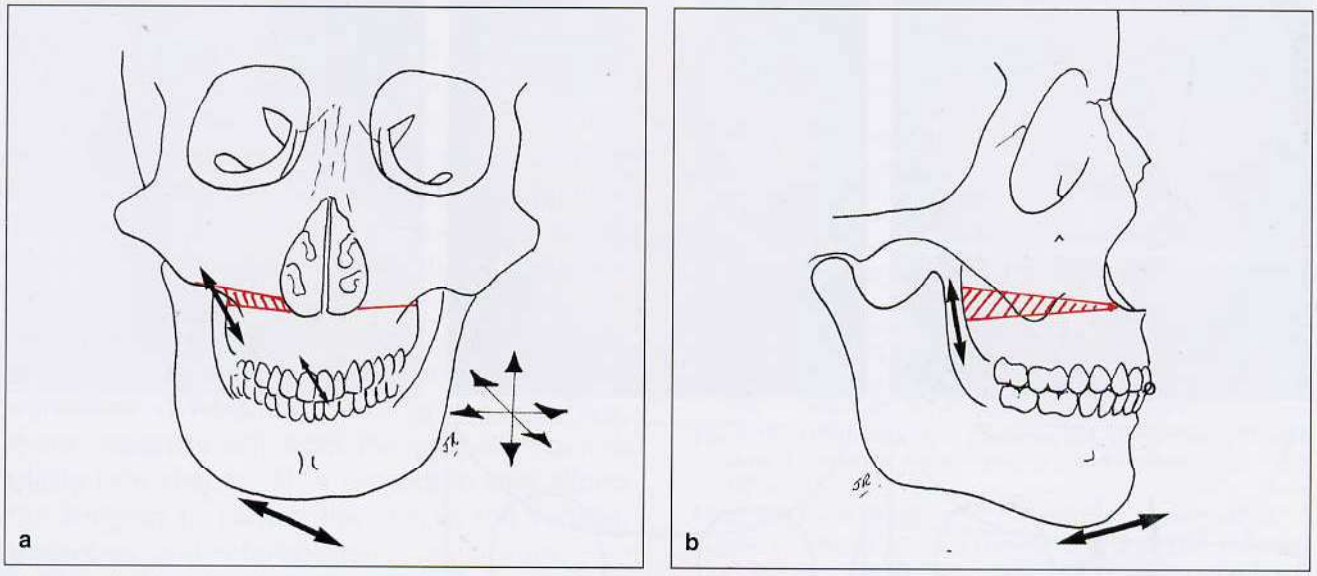


Fig 4-119 The three-dimensional changes are indicated by the *arrows* following correction of the different cants in the anterior and posterior maxilla. *(a)* Frontal view. *(b)* Lateral view.

When surgery will involve both jaws, the orthodontist should not waste treatment time by correcting the dental midlines, which can be corrected surgically. Arch form, however, should be maintained to accommodate the rotational movement during the correction of dental midlines.

An example of facial asymmetry involving the maxilla and mandible is illustrated in Fig 4-118. There is a transverse cant of the occlusal plane, and the mandible is asymmetrical toward the left. The patient has a Class I malocclusion, and the dental midlines coincide. The mandibular dental midline is in the middle of the chin. By correcting the occlusal cant (and, at the same time, the maxillary incisor–lip relationship), facial symmetry is restored (Fig 4-119).

Fig 4-120 The presurgical cant of the occlusal plane is illustrated by the tongue spatula *(a)*, while the presurgical transverse, vertical, and anteroposterior dimensions are demonstrated in frontal *(b)* and profile *(c)* views. The correction of facial asymmetry in all three dimensions is illustrated in frontal *(d and e)* and profile *(f)* views. *(g)* Presurgical anteroposterior cephalometric tracing. *(h)* Surgical correction.

Difference in anterior and posterior occlusal cants

A dual cant of the occlusal plane almost always results from unilateral excessive or deficient growth of the mandibular ramus—eg, patients with unilateral condylar hyperplasia or unilateral hypoplasia (hemifacial microsomia or temporomandibular ankylosis). The unilateral increase in, or lack of vertical growth of, the mandibular ramus secondarily influences the vertical growth of the maxilla and leads to a cant in the occlusal plane. The cant is more severe in the posterior than in the anterior maxilla, necessitating three-dimensional correction.

Asymmetry of the maxilla, mandible, and chin

When the maxilla, mandible, and chin are all involved in the facial asymmetry, three-dimensional correction is usually needed. Correction of the transverse cant of the maxillary occlusal plane will be more challenging than in cases where the anterior and posterior cants are equal. The posterior vertical change will differ on the right and left sides, as well as in the anterior maxilla. This correction will eventually have a profound effect on the chin in the anteroposterior, vertical, and transverse dimensions (see Fig 4-119). Thus, these cases benefit from the propeller genioplasty (see chapter 5), a procedure that allows the surgeon to control the chin in the vertical, transverse, and anteroposterior dimensions.

The patient shown in Fig 4-120 had unilateral condylar hyperplasia on the right side. The asymmetry involved the maxilla, mandible, and chin. Surgical correction included the correction of the occlusal cant with a Le Fort I maxillary osteotomy. This change in the cant was followed by a bilateral sagittal split ramus osteotomy in the mandible. A propeller genioplasty was performed to establish final chin symmetry. Better symmetry of the lower border of the posterior mandible was achieved with an ostectomy of the lower border of the right side of the mandible (after repositioning the inferior alveolar nerve) and the use of part of the ostectomized bone as a graft on the lateral side of the left mandibular body.

Asymmetry of the zygoma, nose, and frontal areas

The zygoma, nose, and frontal areas play an important role in the overall symmetry of the face and should be assessed carefully during the clinical examination. Correction of asymmetry in these areas should be an integral part of the correction of the total treatment of facial asymmetry; however, the treatment is outside the scope of this text.

Recommended Reading

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