THIRD EDITION

Essentials of ORTHOGNATHIC SURGERY

Johan Reyneke, BChD, MChD, FCMFOS (SA), PhD

QUINTESSENCE PUBLISHING

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PREFACE

From the outset, the fundamental purpose of *Essentials of Orthognathic Surgery* was to provide the clinician with basic and "to the point" information regarding the assessment, diagnosis, treatment planning, and treatment of individuals with dentofacial deformities. The general plan of the third edition is unaltered; however, as with most fields in medicine, orthognathic surgery is a dynamic science that is developing exponentially over time. It was therefore exciting to refresh the text by adding new developments and ideas and use clinical cases as demonstration.

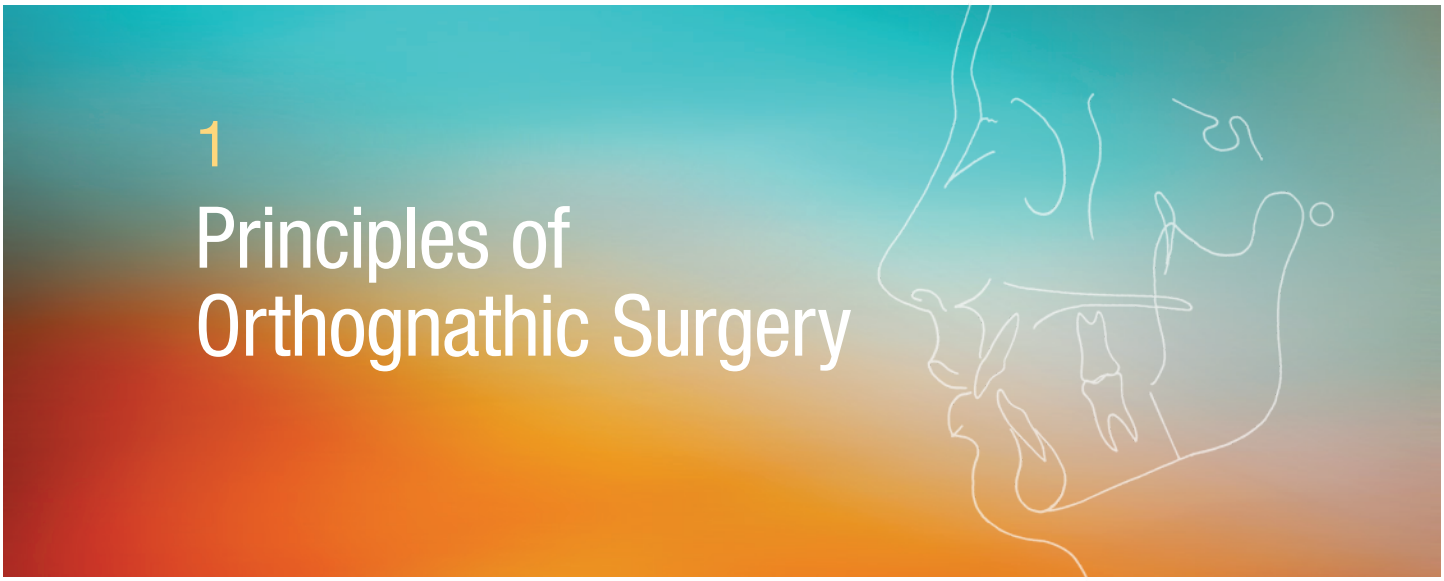
This edition is enhanced by extending several chapters and by the addition of several new sections such as the diagnosis and treatment of hemifacial microsomia, the role of total temporomandibular joint replacement in orthognathic surgery, functional and esthetic nasal control with Le Fort I osteotomy, functional tongue reduction for open bite cases, and indications and implementation of a unilateral sagittal split osteotomy for the correction of mandibular asymmetry.

Since Vilray Blair completed a bilateral osteotomy of the mandible under chloroform anesthesia in 1897, the correction of mandibular dentofacial deformities has developed into a routine surgical procedure that is carried out all over the world. We are fortunate to have been able to stand on the shoulders of giants in the field of orthodontics and oral and maxillofacial surgery who lay the foundations of this surgical science. It is, however, our responsibility to develop the science and art of orthodontics and surgery further and to share our experience with our students and colleagues to the benefit of our patients.

There is an old saying: "A pleasure shared is a pleasure doubled." Successful treatment allows the clinician to share the functional and esthetic changes with not only the patient but also the patient's family and friends and the orthognathic treatment team. We don't change faces, we change lives. I have been blessed with the privilege of correcting dentofacial deformities for more than 40 years and honored by sharing experience gained over this time through this book and other contributions. Sharing experience is an essential ingredient of education, and I thank all the postgraduate residents in oral and maxillofacial surgery who honored me by allowing me to participate in their education.

Acknowledgments

I would like to express my sincere appreciation and gratitude to my good friend and colleague Steven Sullivan, who added further value by contributing two new sections: the management of the airway in the orthognathic surgery patient and 3D virtual treatment planning for orthognathic surgery.



1 Principles of Orthognathic Surgery

When people recognize malpositioned teeth or obvious jaw deformities, they usually seek treatment from an orthodontist, who can improve tooth alignment, function, and facial esthetics. More severe deformities that require a combination of orthodontics and surgery for correction are called *dentofacial deformities*. These deformities can affect physical orofacial function in several ways. Mastication can be impaired, and—especially in severe cases—this impairment can affect digestion and general nutritional health. Lip incompetence due to excessive vertical growth of the maxilla results in mouth breathing, which eliminates the physiologic effect of the nose on breathing. Speech is often affected by dentofacial deformities despite the body's adaptive capabilities. Malpositioned teeth may have a profound effect on proper oral hygiene maintenance, making teeth more susceptible to dental caries and periodontal disease. The patency of the airway and normal breathing is certainly affected by the position of the jaws, and dentofacial deformities are currently considered an important etiologic factor in the development of obstructive sleep apnea. Several types of dentofacial deformities also affect temporomandibular function. The physical effects of a dentofacial deformity are important, but the psychosocial impact of a dentofacial deformity on an individual is often paramount. This type of deformity can profoundly affect the quality of life and may entail lifelong adjustment.

Treatment Options for Dentofacial Deformities

The combination of surgery and orthodontic treatment makes it possible to treat dentofacial deformities that are not possible to correct with orthodontics alone (eg, vertical maxillary excess and severe anterior open bite malocclusion). Orthognathic surgery has created new and exciting opportunities in the treatment of patients with dentofacial deformities and provided the orthodontist with options other than compromised treatment for patients with skeletal disharmony. Experience in orthognathic surgery, an increased understanding of its biologic basis, and a refinement of its art form now enable us to routinely deliver a stable, esthetic, and functional result to patients. When severe skeletal discrepancies result in malocclusion, three kinds of treatment are available: growth modification, orthodontic camouflage, and orthognathic surgery.

Growth modification

This treatment approach should only be considered for mild skeletal deformities. In growing children, dentofacial orthopedics can alter the expression of growth to some extent. However, the extent of growth alteration varies, and this topic remains controversial. The following facial growth patterns may be influenced by growth modification in adolescents:

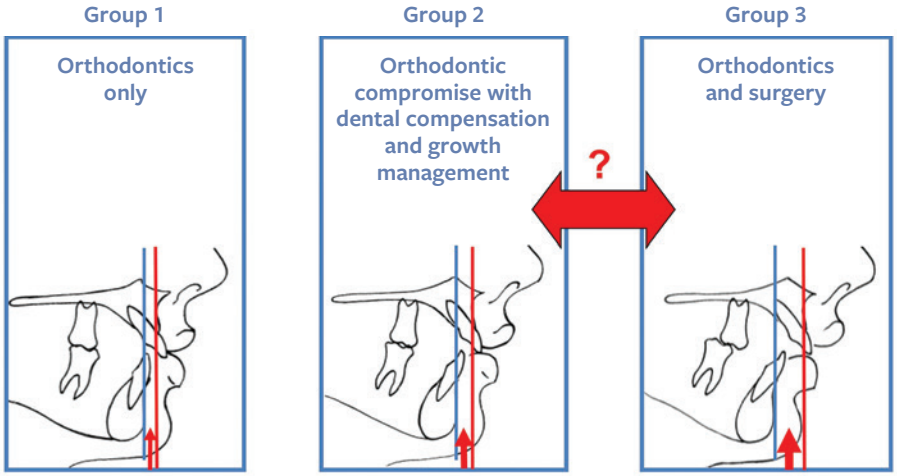


Fig 1-1 Patients who may seek treatment for their malocclusions from an orthodontist can in general be divided into three categories according to the severity of their skeletal deformities. When planning treatment, it can be challenging but is essential to differentiate between groups 2 and 3.

- *Maxillary anteroposterior excess:* Excessive horizontal growth of the maxilla may be impeded by headgear or camouflaged by extraction of the maxillary first premolars and orthodontic retraction of the incisors.
- *Maxillary anteroposterior deficiency:* Moderate improvement can be established by orthodontic protraction.
- *Vertical maxillary excess:* High-pull headgear with temporary anchorage devices can impede the vertical growth of the maxilla and diminish the severity of the deformity.
- *Mandibular anteroposterior deficiency:* Headgear combined with functional appliances may improve mandibular projection.

Skeletal deformities such as mandibular anteroposterior excess, vertical maxillary deficiency, and microgenia cannot be easily influenced by growth modification. In addition, there are some patients who may undergo growth modification for a long period of time with headgear or elastics and end up still requiring a surgical approach. This can be very disappointing and frustrating for the patient as well as their family and health care providers.

Preparing for surgery in these cases would often also require "reverse" orthodontics, decompensating the attempts to compenstate the dentition before orthognathic surgery, prolonging treatment even further.

Orthodontic camouflage

Certain patients with mild skeletal discrepancies would benefit from orthodontic camouflage rather than surgery. Dental compensation for a skeletal deformity, or orthodontic camouflage, may, however, be associated with impaired esthetics, questionable posttreatment stability, and prolonged treatment time (see Figs 1-2 and 1-3). Corrective treatment may require rebanding and a second orthodontic treatment followed by orthognathic surgery.

Orthognathic surgery

Combined orthodontic and surgical correction is considered the best treatment modality for dentoskeletal imbalances once growth has ceased. Although orthognathic surgery is associated with certain risks and challenges, it has become a more refined and less traumatic procedure for patients and therefore is now a reasonable treatment option. Improving skeletal relationships will result in remarkable facial changes, and this is an important goal to consider.

Selecting a treatment

Patients seeking orthodontic treatment have a wide range of functional and esthetic needs and can be divided into three groups (Fig 1-1):

- *Group 1:* Those with a normal skeletal relationship and malocclusions that can be treated using routine orthodontic techniques.
- *Group 2:* Those with mild to moderate skeletal discrepancies. The malocclusions of many of the patients in this group can be corrected by dental compensation and growth management. Both options—pursuing only orthodontic treatment and pursuing combined treatment—will have advantages and disadvantages that must be discussed between the clinicians, the patient, and the patient's parents (if necessary). There are several factors that will determine the treatment decision.

Fig 1-2 (*a to f*) A 19-year-old patient with a skeletal Class II relationship who would be considered to fall into group 3. Her maxillary first premolars were removed and the maxillary incisors retracted in an attempt to correct her occlusion. Unfortunately, the treatment compromised her esthetics and occlusion, resulting in a severe convex profile that accentuated her prominent nose and a Class II deep bite malocclusion.

- *Group 3:* Those with moderate to severe skeletal discrepancy and noticeable facial imbalance. The negative effects of compromised orthodontic treatment for patients in the third group would be unacceptable, making combined surgery and orthodontics the treatment of choice. In cases when the surgical option is not acceptable to the patient, it would be wise for the surgeon not to accept the patient for treatment. Orthodontic treatment alone for patients in this group will certainly worsen the esthetics, have doubtful stability, and possibly have negative long-term periodontic implications (Figs 1-2 and 1-3). On the other hand, only pursuing surgery without orthodontics would also lead to compromise.

An important challenge for the clinician is to differentiate between patients on the borderline between group 2 and group 3. An orthodontic camouflage treatment for patients in group 3 would be a mistake, just as surgical treatment of certain patients in group 2 would be inappropriate. The decision regarding the best treatment for borderline patients is influenced by various factors:

- *The patient's main complaint and preferences.* Some patients are interested only in improving occlusion, whereas esthetic change is a high priority for others. The patient's priority is an important factor in treatment planning: The patient needs to be able to weigh the two treatment options against each other and must therefore be well informed.
  1. Long orthodontic treatment. This often involves headgear, functional appliances, and a different extraction pattern with a compromised treatment outcome. The possibility of worsening esthetics, instability, and long-term periodontal problems should be discussed with the patient (and parents when applicable).
  2. Shorter orthodontic treatment combined with surgery. The surgical implications, possible complications, and improved treatment outcome must be discussed with the patient (and parents when applicable).
- *The orthodontist's preferences and skills.* If the orthodontist has encountered poor surgical results with previous patients, there will be a natural hesitation to continue

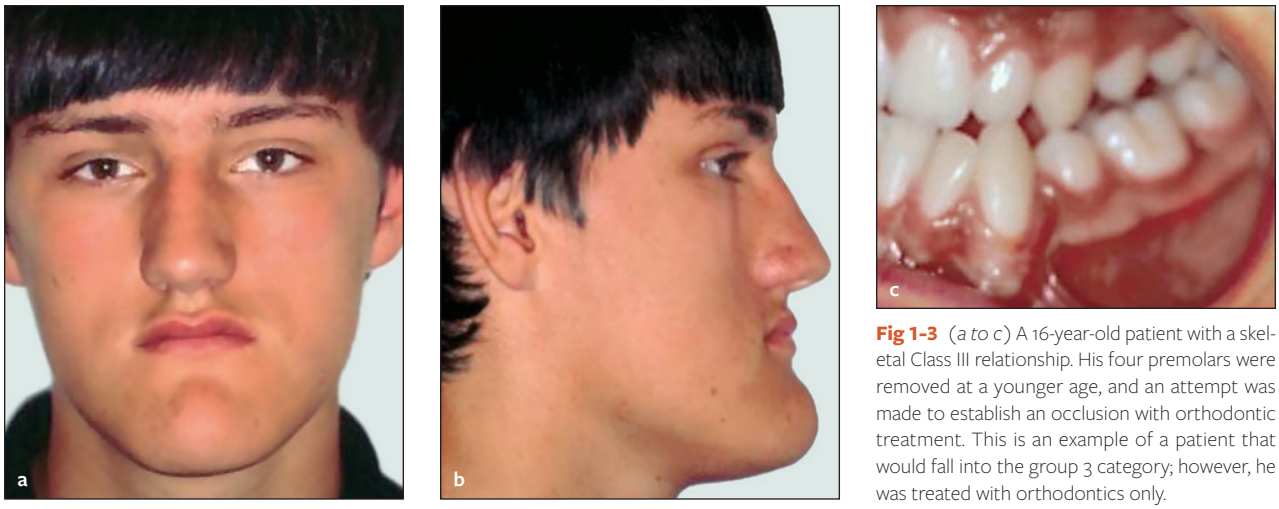


Fig 1-3 (*a* to *c*) A 16-year-old patient with a skeletal Class III relationship. His four premolars were removed at a younger age, and an attempt was made to establish an occlusion with orthodontic treatment. This is an example of a patient that would fall into the group 3 category; however, he was treated with orthodontics only.

to recommend surgery. The orthodontist's confidence in the success of surgery is an important factor.

- *Available surgical skills.* Orthognathic surgical expertise may not be available in the area, and the patient may be unable to travel.
- *Lack of insurance coverage.* The financial implications of orthodontic treatment with the added burden of surgery and hospitalization can be substantial, and this is a significant factor for patients to consider.

Treating patients in group 3 with orthodontics alone (group 2 treatment) may create additional problems (eg, occlusal relapse, worsening of the profile, obstructive sleep apnea (OSA), periodontal and temporomandibular joint decline) rather than solving the existing problem. Surgical treatment of patients in group 2 is appropriate when camouflage treatment would produce an unacceptable esthetic result or when orthodontics alone cannot achieve the desired facial change. Camouflage treatment also can be considered an alternative treatment method that should render acceptable functional, stable, and esthetic results.

Treatment Objectives in Orthognathic Surgery

Four treatment objectives are fundamental in orthognathic surgery: (*1*) function, (*2*) esthetics, (*3*) airway patency, and (*4*) stability of results. These objectives form the basic goals in treating patients with dentofacial deformities and often go hand in hand.

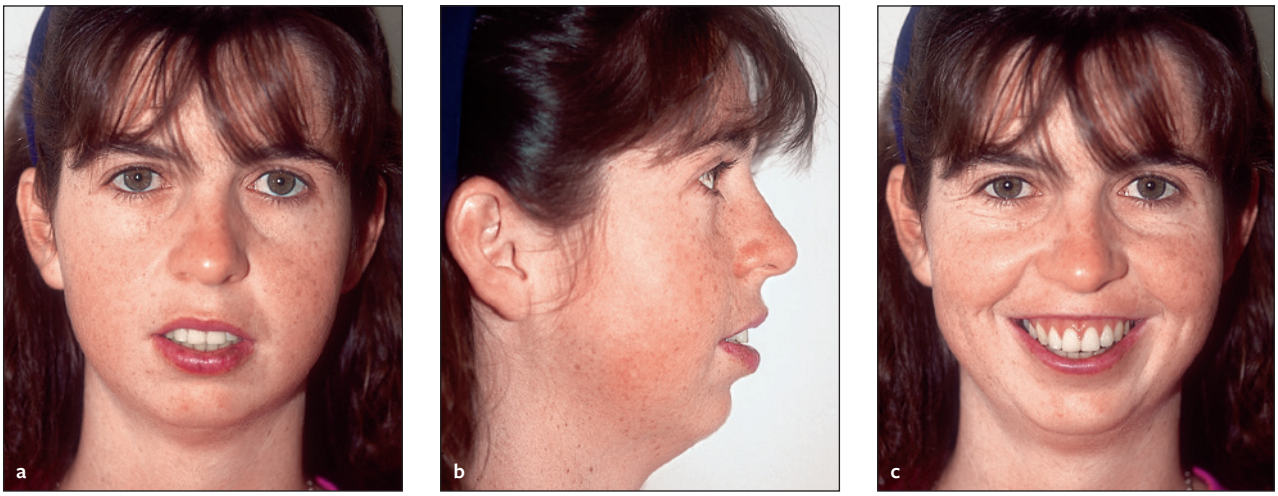
Function

Functional and esthetic deformities often exist concurrently, so treatment should be designed to correct both. The orofacial functional objectives should not only incorporate the bite and chewing functions but also include normal breathing, speech, swallowing, and temporomandibular joint function. When correcting a functional problem, the clinician should make full use of the opportunity to improve facial esthetics at the same time. It is particularly challenging to treat patients whose function is poor but esthetics are already good. Careful planning is essential to avoid additional esthetic deformity while providing optimal functional relationships.

Esthetics

The patient's main concern is often their facial appearance, and it is paramount to establish what the patient perceives as esthetically wrong. As Leo Tolstoy said in *Childhood*, "I am convinced that nothing has so marked influence on the direction of a man's mind as his appearance, and not his appearance itself so much as his conviction that it is attractive or unattractive."

Esthetic imbalance is often the result of a significant dentoskeletal deformity. Esthetic results can be improved by surgery alone in some patients, although the functional problem will not necessarily be treated. For example, if a patient with mandibular anteroposterior deficiency is treated with surgical advancement of the chin, this may result in a Class II malocclusion. In contrast, for a patient with vertical maxillary excess, it may be possible



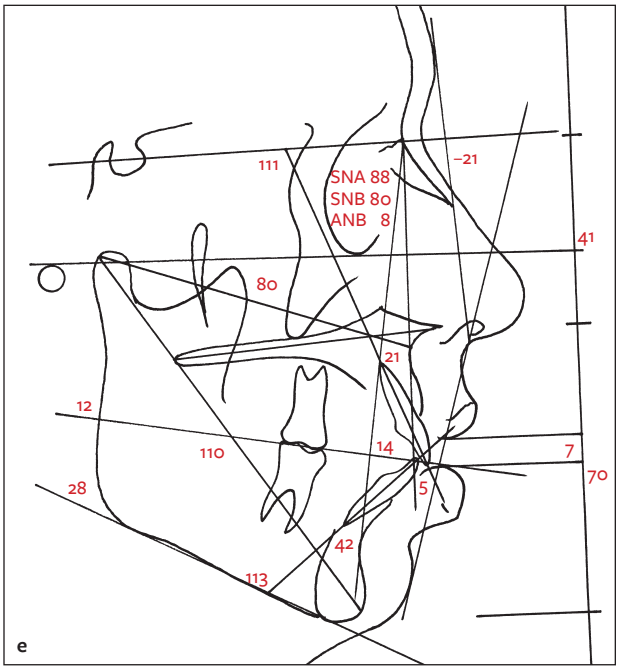


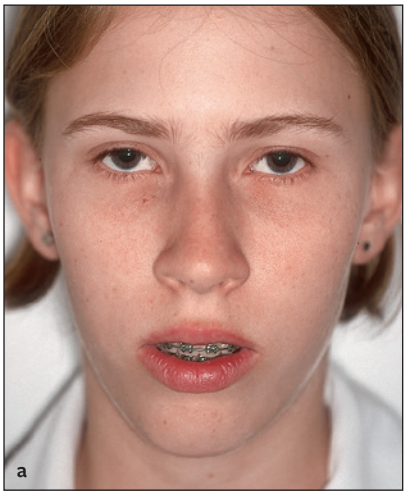
Fig 1-4 This 20-year-old patient was referred to the surgeon with the main complaint that her chin appeared too small and she did not like her "gummy smile." Previous orthodontic treatment lasted 3 years and consisted of extraction of four first premolars, retraction of maxillary incisors, and proclination of mandibular incisors. She was not offered the option of surgical correction of her skeletal problem. (*a*) Frontal view. (*b*) Profile. (*c*) Smile. The dental compromise for the skeletal disharmony is evident in the occlusion (*d*) and the cephalometric analysis (*e*). The ideal treatment for this patient would have been the preoperative orthodontic creation of a Class II malocclusion (possibly with a different extraction pattern), followed by the vertical repositioning of her maxilla and advancement of her mandible. In this case, however, an acceptable, although compromised, esthetic result was achieved by superior repositioning of her maxilla and advancement genioplasty, while the existing occlusion was maintained.

to achieve a Class I occlusion by orthodontic treatment alone; however, an ideal esthetic result is not possible.

Because the orthodontic placement of the teeth dictates surgical movement (and ultimately facial changes), the orthodontist must carefully assess patients with musculoskeletal deformities before orthodontic treatment is begun. Accurate preoperative orthodontic and surgical planning that considers the indicated surgical movement is necessary to ensure not only good functional results but also an optimal esthetic outcome. As seen in the patient in Fig 1-4, the dentition has been compromised for skeletal vertical maxillary excess and mandibular anteroposterior deficiency. Function and questionable stability have been achieved; however, the esthetic result is poor. An acceptable result is achieved after surgical compromise.

The patient in Fig 1-5 decided against surgical correction of her Class II malocclusion and vertical maxillary excess dentofacial problem. The orthodontic compromise treatment plan consisted of extraction of first maxillary premolars, retraction of maxillary incisors, and establishment of an occlusion. Four months after beginning orthodontic treatment, the patient thought her appearance was worsening and realized that this treatment option would not be acceptable to her. It was then decided to decompensate the maxillary incisors to open the extraction spaces in the maxilla. The surgical treatment plan consisted

Fig 1-4 (*cont*) (*f*) Postoperative frontal view. (*g*) Postoperative profile. (*h*) Smile.



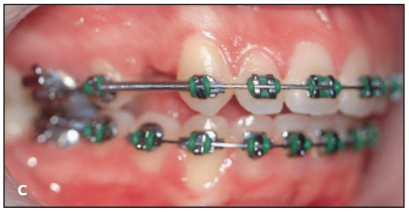
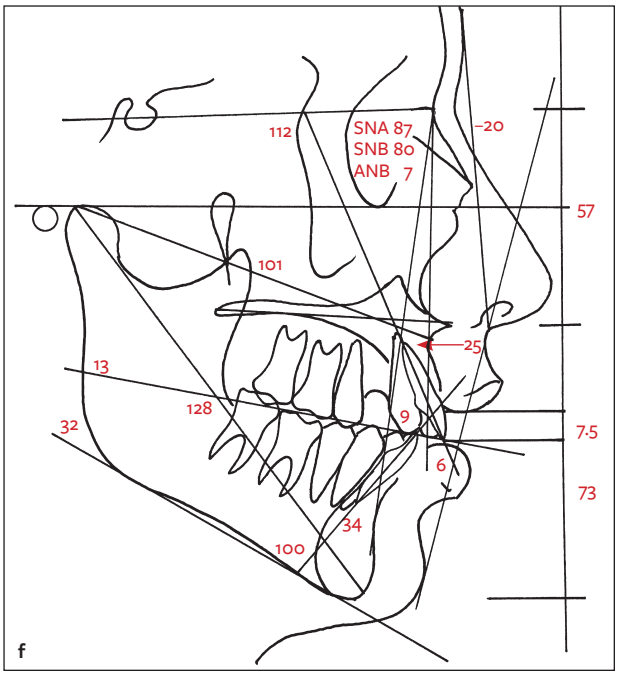


Fig 1-5 Because the patient decided not to have surgery, the compromise orthodontic treatment consisted of extraction of the maxillary first premolars and retraction of the maxillary incisors. The deteriorating esthetic results are evident in the frontal (*a*) and profile (*b*) views. (*c to e*) The diagnosis of vertical maxillary excess and micrognathia with a Class II malocclusion is confirmed by the occlusion.

of a two-piece Le Fort I maxillary osteotomy, superior repositioning of the maxilla, and surgical closure of the extraction spaces by advancement of the posterior maxillary segment (see Figs 1-5g and 1-5h). The mandible would autorotate, and the chin would be surgically advanced by means of a sliding genioplasty. In this case, an acceptable surgical solution could be found (see Figs 1-5i to 1-5m); however, in other cases, the surgical compromise for the orthodontic compromise may be limited from either an esthetic, functional, or stability aspect. In some patients with orthodontic compromise, the compromised dentition may cause challenges with solving the dentofacial problems and may even prevent a solution.



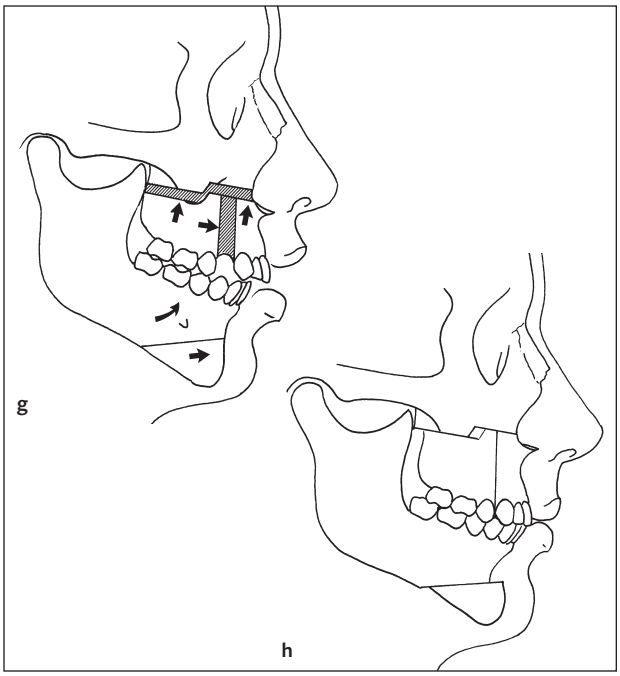
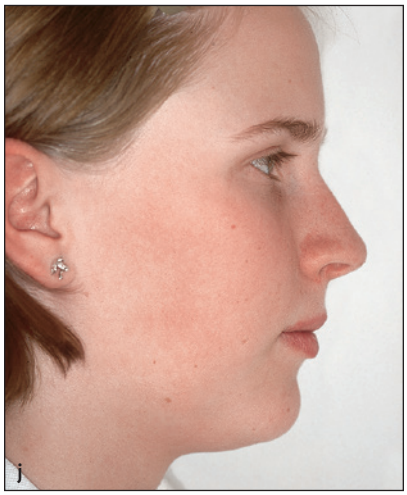


Fig 1-5 (*cont*) (*f*) Cephalometric tracing confirming diagnosis. (*g*) Surgical treatment plan. The maxillary incisors were decompensated, opening the spaces where the first premolars had been extracted. The surgery consisted of a two-piece Le Fort I maxillary osteotomy, superior repositioning of the maxilla, and advancement of the posterior segment to close the spaces. The chin was advanced by means of a sliding genioplasty. (*h*) Postoperative dental, skeletal, and soft tissue positions. (*i*) Postoperative frontal view. (*j*) Postoperative profile. (*k to m*) Postoperative occlusion.



Airway patency

There are several anatomical risk factors that may play a role in causing OSA. These include regional obesity, alteration of the nasal cavity, enlargement of other critical soft tissue structures of the upper airway, inadequate pharyngeal muscle tone, and a retrusive maxillomandibular skeleton. Patients with dentofacial deformities may suffer from OSA or be candidates to develop OSA. Some changes caused by dentoskeletal treatment when the patient is young may result in development of OSA when the patient gets older. A thorough medical and sleep history should be taken and a physical examination completed when indicated. See "Airway Considerations in Orthognathic Surgery" in chapter 2.

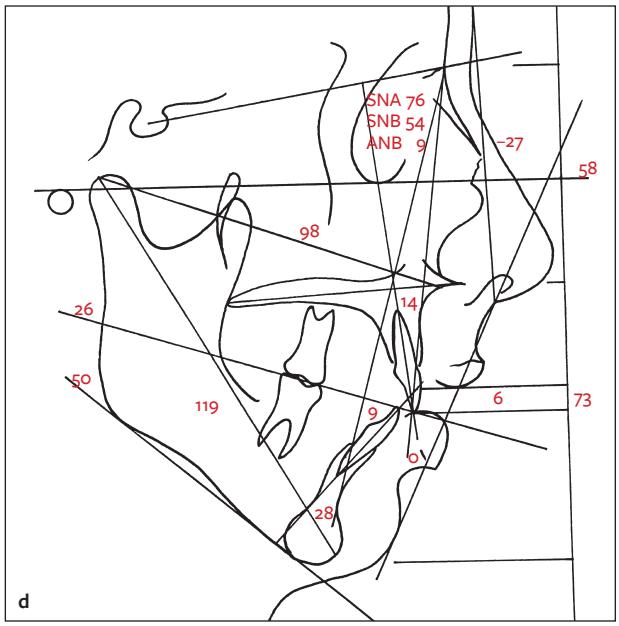


Fig 1-6 A 15-year-old patient reported an inability to bite certain foods with her front teeth. She recalled that she had an open bite before orthodontic treatment. Her four first premolars were removed as part of her orthodontic treatment, which lasted 2 years. Her bite was good at the time of band removal. Her frontal (*a*) and profile (*b*) views revealed a convex profile, maxillary vertical excess, and mandibular anteroposterior deficiency. (*c*) She had a Class II anterior open bite malocclusion. (*d*) The skeletal soft tissue and dental relationship is evident on the cephalometric tracing. The patient was rebanded and the maxillary arch aligned in three segments; the anterior segment contained the incisors, whereas the right and left posterior segments included all the teeth from the canines to the second molars. The surgery consisted of a three-piece Le Fort I maxillary osteotomy with superior repositioning and expanding of the posterior segments, which allowed the mandible to autorotate. The chin was advanced by means of a sliding genioplasty. The acceptable esthetic and functional result is seen in the postoperative frontal view (*e*) and profile (*f*) as well as in the occlusion (*g*).

Stability

A treatment outcome of good function of pleasing esthetics is not acceptable without stability. Certain orthodontic tooth movements have questionable stability. An example is the extrusion of teeth to correct a skeletal anterior open bite; any preoperative orthodontic attempt to correct this type of open bite adds significant instability to the overall result. After the jaws are surgically repositioned beyond their biologic parameters, they will relapse into a more harmonious musculoskeletal relationship for the individual. Figure 1-6 demonstrates a case in which the orthodontic treatment of an open bite led to poor stability and unacceptable esthetics. Occlusal stability at any moment is the result of the sum of all the forces acting against the teeth (Enlow, 1990). A good occlusion is often the best retainer. It has been shown that the use of sound orthodontic mechanics and surgical techniques will produce optimal stability, function, airway, and esthetics.

Patient Consultation

There will be separate consultations with the orthodontist and with the surgeon, and each will have both an initial consultation to inform the patient about treatment and a definitive consultation to begin the treatment. Before the final consultation with the patient, the orthodontist and surgeon will formalize and agree on a diagnosis and treatment plan.

First orthodontic consultation

Because people with malpositioned teeth and a jaw deformity usually seek treatment from an orthodontist, the orthodontist must usually discuss the possible need for a surgical procedure at the initial consultation. During the first orthodontic consultation, a clinical examination is performed and the appropriate records obtained. The surgeon will need a copy of these records as well.

Definitive orthodontic consultation

The final pretreatment consultation takes place only after a systematic patient evaluation has been conducted and the orthodontist and surgeon have agreed on a final treatment plan. It is mandatory that the patient (and perhaps the parents or spouse) be well informed. Well-informed patients follow instructions and, as a general rule, are easy to treat.

Orthodontists and surgeons should develop their own methods of informing patients about treatment options and gaining their confidence. It is important to keep explanations simple and to use the patient's radiographs and dental casts to demonstrate the problems. Solutions for the problems should be discussed in general terms, and the need for surgery must be explained. The patient and their family (if applicable) must understand the importance of properly aligning the teeth, and that the bite may not improve or even get worse during the preoperative phase. Word choice is important for the orthodontist in discussing the type of surgery required. Terms such as *reposition*, *lengthen*, or *shorten* should be used when describing the surgical procedures. The final and more detailed explanation of the surgery should be left to the surgeon. Treatment results of patients with similar problems may be used to demonstrate specific treatment objectives.

For most patients, the treatment time is extremely important, but it is preferable not to give a specific length of time. It is important, however, to give the patient a general idea of the length of treatment and a treatment profile explaining various phases of the treatment, the sequence of the stages, and the time each phase could take. The patient should be alerted to factors that might influence the treatment time and surgical precision, such as bone density, periodontal disease, patient cooperation, age, and tooth extractions. It is also important at this stage to inform the patient about the cost of the orthodontic aspect of the treatment.

Explanation of typical treatment profile

A typical treatment profile consists of six phases:

1. *Placement of orthodontic bands on the teeth*. Any necessary extractions of teeth (including third molars) are completed at this time. The orthodontic bands are usually fitted 2 to 3 weeks later.
2. *Preoperative/preparatory orthodontic phase (9 to 18 months, on average)*. The teeth are now aligned in their optimal positions in each arch. When the orthodontist is satisfied that this preparation is complete, the patient is referred back to the surgeon.
3. *Surgical phase and healing time (4 to 6 weeks)*. The surgeon surgically repositions the jaw or jaws into their most favorable relationship to establish a good occlusion (bite) and balanced facial proportions. After a short healing period, the patient returns to the orthodontist for the final correction of the bite. It is very important that the patient see the orthodontist 2 to 3 weeks after surgery for postoperative orthodontic control.

4. *Postoperative orthodontic phase to perfect the bite (3 to 6 months).* The purpose of orthodontics after the surgery is to refine the bite. Minor tooth movement occurs during this phase to finalize the occlusion and achieve a satisfactory result.
5. *Removal of orthodontic bands.*
6. *Retention phase (6 to 12 months).* When orthodontic treatment has been completed, the teeth that have been moved through bone need to be stabilized in their new positions for a time. The orthodontist manufactures and fits a retention appliance, which must be worn by the patient as instructed by the orthodontist.

The duration of the presurgical orthodontic phase will vary as the severity and type of malocclusion varies. For example, mandibular advancement will be performed earlier in the orthodontic phase for Class II deep bite cases than for mandibular setback cases. In fact, in some cases, the orthognathic surgery may be performed before the orthodontic treatment begins. When performing surgery first, it is mandatory that an acceptable, stable occlusion can be established at the time of surgery. This treatment approach requires an experienced and competent orthodontist and surgeon.

First surgical consultation

The initial surgical consultation includes a general discussion of the basic principles of combined orthodontic and surgical treatment and why surgery is necessary. Most patients are apprehensive at this consultation, and the fact that they may need surgery has often come as a surprise to them. The surgeon should therefore use this consultation as an opportunity to inform the patient about the orthognathic surgical principles and to gain the patient's confidence. The importance of a comprehensive treatment plan developed by both the orthodontist and surgeon is explained. At this consultation, a systematic patient evaluation is conducted, and records are obtained if not previously sent from the orthodontist.

Definitive surgical consultation

The definitive surgical consultation is conducted once the orthodontist and surgeon have finalized a treatment plan. The need for orthodontic preparation before surgery is confirmed. The basic principles of the specific surgical treatment, general sequence of events of the surgical phase of treatment, hospitalization time, recovery period, and need for a soft food diet are discussed. The surgical objectives may be explained by treatment results of patients with similar dentofacial problems. A patient information brochure is provided, and the patient is reassured during the preoperative orthodontic phase that he or she is welcome to discuss with the surgeon any concerns regarding the planned surgery. The estimated costs, including costs of the planned surgery, hospitalization costs, and the anesthetization fee, should also be discussed at this time.

Consultation with Other Disciplines

Consultation with practitioners in other disciplines may be needed in the treatment of patients with a dentofacial deformity.

Periodontics

In general, most periodontal diseases should be treated prior to orthodontic banding. The teeth and periodontium should be sound before treatment. The importance of oral hygiene during the orthodontic treatment phase should be stressed, and the possibility of periodontal treatment after debanding should be mentioned to the patient.

Prosthodontics

Any work on fixed partial dentures is preferably performed after a period of orthodontic retention. However, it is often advantageous for the patient to consult with a prosthodontist before beginning treatment. The prosthodontist can contribute valuable insight into certain aspects of the surgical/orthodontic treatment and prosthodontic rehabilitation. For example, in a patient with congenitally missing lateral incisors, should the interdental spaces be closed, or should spaces be maintained and the missing teeth be replaced by implants or fixed partial dentures? For edentulous patients or those with a limited number of teeth that would not require orthodontic treatment, the preoperative prosthodontic consultation is mandatory.

Implant dentistry

It is often possible to place the necessary implants at the time of orthognathic surgery. It is important, however, to keep any postoperative orthodontic tooth movement in mind. Dental implants can often be placed more accurately after band removal and a short period of retention. However, it will be more expensive for the patient to undergo two separate surgeries. For patients requiring bone grafts before implants can be placed, the surgeon should consider placing the bone grafts during orthognathic surgery.

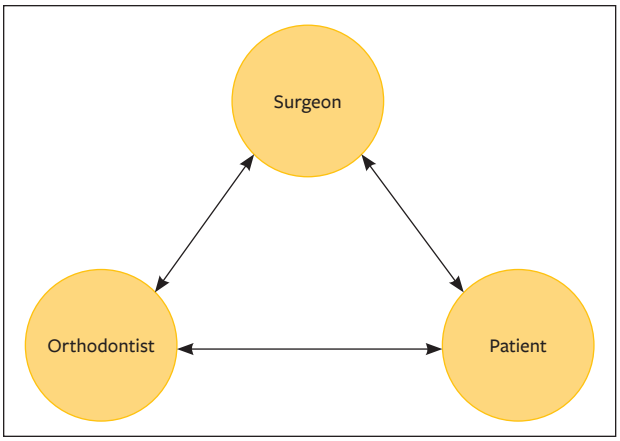


Fig 1-7 Kindness, communication, and free flow of information between the surgeon, orthodontist, and patient facilitate efficient and successful treatment and ensure patient confidence.

General dentistry

Problems such as dental caries, fractures, periodontitis, and poor-fitting crowns should be addressed before treatment begins. The condition of certain teeth may influence the decision of which teeth are extracted for orthodontic reasons. The initial referral to the orthodontist or surgeon is often made by the general practitioner, and it is important to keep him or her informed of the treatment plan and the progress of the patient's treatment. The general practitioner should be part of the treatment team.

Importance of communication

Accurate treatment planning and meticulous orthodontic and surgical practice are essential to the achievement of treatment objectives. Just as important, however, is communication between the clinician and the patient, as well as between clinicians. It is crucial to have adequate communication between the orthodontist, patient, and surgeon about the patient's main complaint and concerns, dentofacial diagnosis, treatment possibilities, and treatment objectives (Fig 1-7). The confident sharing of information with the patient will build trust between patient and clinician. Remember, people want to know how much you care before they care how much you know.

The communication between the surgeon and the orthodontist is equally important. Lack of communication here not only hampers the development of an efficient and sound treatment plan but also generally leads to poor treatment results. Patients are extremely concerned about poor or lacking communication between the orthodontist and the surgeon, and it can lead to confusion. Clinicians should refrain from sending messages to each other via the patient.

Treatment plan

The development of a treatment plan has three advantages:

1. It represents an agreement between the orthodontist and the surgeon on how the patient will be treated.
2. The treatment plan and objectives can confidently be presented to the patient without contradictions.
3. Although the treatment plan may be changed when indicated, it serves as a solid guideline.

The treatment plan may need to be revised or changed after the preoperative orthodontic treatment is under way. The reason for a change in treatment plan and the solution should be discussed by the orthognathic team so that there will be no surprises during the immediate preoperative surgical consultation. Superb orthodontic alignment of teeth and excellent surgical technique do not substitute for good clinical judgment, optimal decision making, proper communication, and empathy with patients.

Recommended Reading

Arnett GW, McLaughlin RP. Facial and Dental Planning for Orthodontists and Oral Surgeons. St Louis: Mosby, 2004.

Bell WH. Modern Practice in Orthognathic and Reconstructive Surgery, vol 1. Philadelphia: Saunders, 1992.

Enlow DH. Facial Growth, ed 3. Philadelphia: Saunders, 1990.

Epker BN, Stella JP, Fish LC. Dentofacial Deformities: Integrated Orthodontic and Surgical Correction, vol 1. St Louis: Mosby, 1994.

Gasparini G, Boniello MD, Moro A, Di Nardo F, Pelo S. Orthognathic surgery: A new preoperative informed consent model. J Craniofac Surg 2009;20:90–92.

Naini FB. Facial Aesthetics: Concepts & Clinical Diagnosis. Wiley-Blackwell, 2007.

Proffit WR, White RP. Surgical Orthodontic Treatment. St Louis: Mosby, 1990.

Sarver DM, Proffit WR, White RP. Contemporary Treatment of Dentofacial Deformities. St Louis: Mosby: 2002.

Spalding PM. Craniofacial growth and development. In: Miloro M, Ghali GE, Larsen P, Waite P (eds). Peterson's Principles of Oral and Maxillofacial Surgery, ed 3. Shelton, CT: People's Medical Publishing House-USA, 2012:1189–1238.

Wolford LM, Stevao ELL, Alexander CM, Goncalves JR, Rodrigues DB. Orthodontics for orthognathic surgery. In: Miloro M, Ghali GE, Larsen P, Waite P (eds). Peterson's Principles of Oral and Maxillofacial Surgery, ed 3. Shelton, CT: People's Medical Publishing House-USA, 2012:1263–1294.

2

Systematic Patient Evaluation

With contributions by Steven Sullivan, DDS

There must be clear and effective communication between the orthodontist and the maxillofacial surgeon from the outset of treatment to achieve the best results from surgical therapy. Through this close relationship, a full exchange of information and data can be made. Each practitioner involved in the patient's care should be familiar with the standard records required, and the data on the patient should be shared regardless of who actually performs the investigations. Treatment should commence only after both the orthodontist and the surgeon have consulted with the patient, a treatment plan has been jointly prepared, and both clinicians have a copy of the patient's records. Orthognathic surgeons should have a thorough understanding of orthodontic treatment principles to enable them to communicate sensibly, to plan realistically, and to know what can be expected from the orthodontic treatment. Conversely, orthodontists should understand the surgical possibilities, limitations, and requirements to make the partnership ultimately advantageous to the patient.

A systematic examination is necessary to adequately evaluate and plan treatment for patients with dentofacial deformities. In routine cases, this evaluation includes the following:

- General patient evaluation
- Sociopsychologic evaluation
- Esthetic facial evaluation
- Radiographic evaluation
  - Lateral cephalometric
  - Posteroanterior cephalometric
  - Full-mouth periapical
  - Panoramic
- Occlusion and study cast evaluation
- Temporomandibular joint evaluation

General Patient Evaluation

Hereditary tendencies in the development of dentofacial deformities

The term *dentofacial deformity* is generally used to describe a significant disproportion of the jaws in association with malocclusion. Jaw deformities are thought to be more common among individuals with genetic backgrounds that are crossed between different racial and ethnic groups as compared with those from isolated human populations. It is assumed that about one-third of children who present with a severe Class III malocclusion will have a parent with the same problem and that one-sixth of these children will have siblings with the same problem. A short face growth pattern with a deep bite malocclusion is more frequently found in Caucasians, while bimaxillary protrusion with anterior open bite and micrognenia is more prevalent among individuals of African descent.

Knowledge and an understanding of normal facial growth and development as well as the effect of malformations on associated facial structures is useful in diagnosis and treatment planning as well as to limit complications during treatment. Factors that are known to alter facial growth and cause dental malocclusion and skeletal deformities may include the following: (1) syndromes, (2) hereditary factors, (3) environmental and neuromotor effects, (4) trauma, and (5) pathology (eg, tumors).

Medical history

The patient's medical history can be obtained by means of a questionnaire that the patient fills out at the first consultation. The questionnaire should be thorough so that no important areas are overlooked. The data are used to focus follow-up questions. Existing medical problems must be further evaluated and discussed with the appropriate physician or specialist. The potential for these medical problems to complicate general anesthesia or reconstructive surgery must be evaluated. Risk management and potential complications related to any medical problem should be discussed with the patient and carefully documented. Other medical specialists treating the patient should be consulted as necessary, and reports on existing conditions and drugs the patient may be taking should be obtained. It is also important to look for and recognize congenital syndromes because these patients may have unusual growth patterns and may respond unpredictably to orthodontic or surgical treatment.

Dental evaluation

History

Previous restorative, orthodontic, orthognathic surgery, periodontal, and facial pain treatment should be reviewed. The dental history is often an important barometer of the patient's probable commitment to future treatment.

General evaluation

Oral hygiene and previous dental treatment are good indications of the patient's "dental IQ" and motivation for future treatment. Caries, periodontal and periapical pathology, and the presence of unerupted and/or impacted teeth should be noted. The need for implants should be evaluated for possible inclusion in the final treatment plan. However, final prosthetic decisions are deferred until surgical orthodontic treatment has been completed.

Periodontal considerations

The prognosis for any periodontally affected teeth is established and the effect of orthodontic and surgical treatment considered. Periodontal disease and inadequately attached gingiva must be managed before commencement of orthodontic treatment. Long-term management, further periodontal treatment, and prognosis should be discussed with the periodontist and the patient.

Occlusal–oral function evaluation

Mastication, swallowing, mouth breathing, modified eating habits, and maximum mouth opening are documented. Snoring and breathing during sleep (eg, obstructive sleep apnea) should be noted and investigated. The effect of the dentofacial deformities on speech should be noted and the patient referred for pretreatment speech evaluation. Tongue thrust, thumbsucking, and lip-biting habits should be noted and their effect on the deformity evaluated.

Sociopsychologic Evaluation

Evaluation of the patient's sociopsychologic makeup is often neglected. It is important to consider the patient's motives for treatment and to determine the patient's expectations from treatment. There are two basic causes of patient dissatisfaction with the treatment outcome: (*1*) failure of the clinician to clearly inform the patient of realistic and probable treatment results (especially esthetic results), and (*2*) overoptimistic expectations of the patient regarding the results of treatment.

At the first consultation, the patient should be introduced to the concept of orthognathic surgery gently but confidently. It is imperative that from the start, the clinician provides the patient with a realistic and understandable overview of orthognathic treatment principles and general treatment possibilities in relation to the patient's specific dentofacial problem. Understanding the patient's concerns, motivations, and expectations will provide insight into the patient's psychologic health.

The clinician should refrain from overwhelming the patient with overt enthusiasm about the benefits of treatment, but rather should allow the patient to make his or her own decision. Some patients may need time to discuss future treatment with family or friends. Further counseling about realistic treatment expectations may be necessary, and it may even be best to delay treatment until the patient seeks psychologic guidance and is able to cope with treatment realities.

The perception of one's own appearance is often the "motor" behind direction in life. Surgical-orthodontic change of facial appearance inevitably has an effect on this motor. The following are some relevant questions for the patient to consider:

Sociopsychologic Evaluation

1	Who attends the first consultation?									
	Patient		Father		Mother		Spouse		Friend	
2	What does the patient think is wrong?									
	Function		Esthetics		Pain		Speech		None	
3	Patient's perception of esthetic severity:									
	1	2	3	4	5	6	7	8	9	10
	Mild				Moderate					Severe
4	Patient's perception of functional severity:									
	1	2	3	4	5	6	7	8	9	10
	Mild				Moderate					Severe
5	Patient's ability to define problem:									
	1	2	3	4	5	6	7	8	9	10
	Poor				With assistance					Good
6	Expectations of treatment:									
	1	2	3	4	5	6	7	8	9	10
	Unrealistic				Unclear					Realistic
7	Motivation									
	1	2	3	4	5	6	7	8	9	10
	Low				Moderate					High

Fig 2-1 Sociopsychologic evaluation form.

- *What does the patient (and/or the patient's parents) think is wrong?* Many individuals are able to identify, explain, and prioritize their concerns, which may vary from functional to esthetic problems. A patient is often referred by his or her dentist for treatment for conditions unfamiliar to the patient or family. The patient may be seen by the dentist not because of their own concerns but those of their parents. For these patients, it is paramount to explain their specific problems and the reasons for correction, including the risks of nontreatment, the treatment required, and the associated risks of treatment. It may come as a shock to the patient and family members that the patient may need surgery. It is therefore important to comprehensively discuss with the patient (and family when necessary) the concepts related to surgery combined with orthodontic treatment. The advantages and disadvantages of combining orthodontics with surgery, alternative treatments, and compromises should be discussed; if possible, results from previously treated patients should be reviewed. This information will help the patient and family to make an informed decision regarding treatment.
- *Why is treatment required?* The motivation for treatment is often a good predictor for the patient's cooperation during treatment.
- *Why is treatment required now?* The timing of seeking treatment is influenced by various factors including finances, onset of symptoms, and late diagnosis, among others.
- *What is expected from treatment?* The expectations and priorities of patients differ. For patients with severe facial deformities, the esthetic change is more important than functional occlusal correction. Patients who need correction of their malocclusion but prefer not to have any esthetic facial change can present a treatment challenge to the surgeon and the orthodontist.

Figure 2-1 shows a sociopsychologic evaluation form, which should give the clinician an overview of the patient's sociopsychologic status, indicating any existing problems and possible need for consultation with a psychologist.

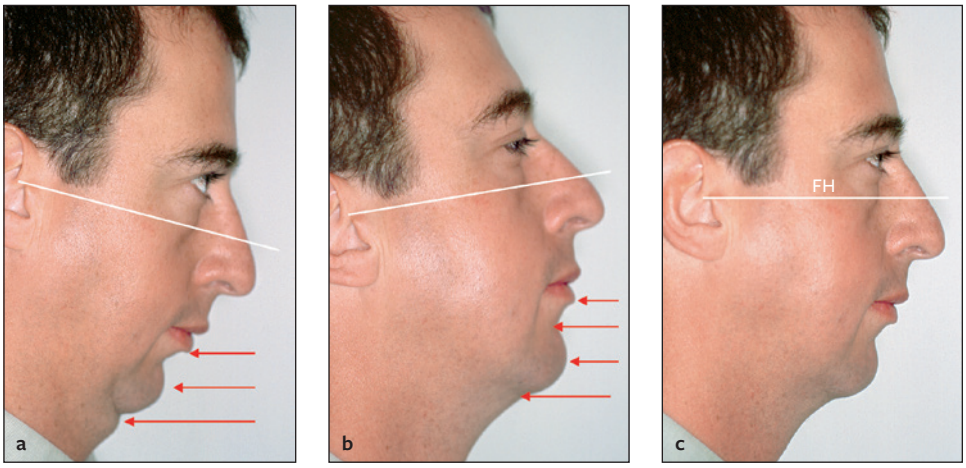


Fig 2-2 Clinical assessment of the chin and throat area is possible only when the head is in natural posture. Note the differences with the head tilted down (*a*), tilted up (*b*), and with the head in natural posture (*c*). The *white line* represents the Frankfort horizontal (FH) plane.

Esthetic Facial Evaluation

The clinical assessment of the face is probably the most valuable of all diagnostic procedures. The esthetic facial evaluation should be performed in a systematic fashion with the patient standing or seated comfortably. Primary emphasis should be placed on frontal esthetics because that is how people see themselves. Data should be recorded on a special form that can also serve as a checklist. Only abnormal and pertinent data should be recorded. Balance and proportion between the various facial structures in the individual are more important than numeric values. It is also important to compare the facial proportions with the patient's general build and posture (ie, corporofacial relationship).

The clinical examination of the face should always be done with two questions in mind:

1. Would orthodontic-surgical treatment be able to correct the dental, skeletal, and soft tissue structure diagnosed as abnormal?
2. How would the orthodontic-surgical correction of the abnormal structures influence the facial structures considered to be normal?

It is often possible to correct the malocclusion of patients with dentofacial deformities by means of *compromised orthodontic treatment*, meaning an orthodontic-dental compromise for a skeletal jaw discrepancy resulting in an acceptable long-term functional and stable occlusion and facial esthetics. The fear of surgery, financial issues, unsatisfactory surgical experience of the orthodontist, and feasibility of correction by compromised orthodontic treatment will influence the orthodontist to implement orthodontic treatment for a skeletal deformity.

The patient should be examined in natural head posture, with the teeth in centric occlusion and the lips relaxed. *Natural head posture* is the position in which the patient orients his or her head and that feels most natural. Figure 2-2 illustrates the profound effect a change in head posture may have, for example, on chin position, chin-throat angle, and chin-throat length. Skeletal and soft tissue changes can therefore only be planned with the head in natural posture and the lips relaxed to ensure appropriate soft tissue changes. Orthodontic and surgical treatment are planned to produce ideal function in centric occlusion. All examination data should therefore be recorded in centric occlusion. However, patients with vertical maxillary deficiency and severely closed bites are an exception to this rule. Because of the inadequate height of the maxilla, these patients' bites are overclosed, leading to distortion of their lips. To accurately evaluate these patients' lips and maxillary incisor–upper lip relationships, they should be evaluated in an open bite posture. A wax bite can be placed between the teeth to increase the vertical dimension until the lips just part. The lack of tooth exposure, lip shape and thickness, anteroposterior position of the chin, labiomental fold, upper lip length, nasolabial angle, and soft tissue thickness can now be assessed more meaningfully. Figure 2-3 illustrates the profound changes in soft tissue characteristics in a patient with vertical maxillary deficiency in centric relation and in the open bite position.

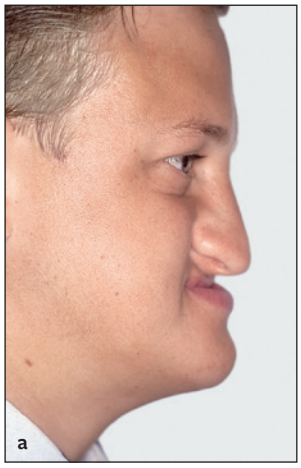


Fig 2-3 Individual with vertical maxillary deficiency. Note the change in the shape of the lips and lower facial height with the teeth in occlusion (*a*) and with the mandible rotated open until the lips just part (*b*).

Fig 2-4 The profile of the lower third is profoundly different when the lips are forced together (*a*) versus in repose (*b*).

It is imperative that the patient be examined with the lips in a relaxed position, because it is impossible to assess the relationship between the soft tissue and the hard tissue when the lips are forced together. Figure 2-4 demonstrates the effect of muscular compensation on the lips and chin. Note the change in the interlabial gap, labiomental fold, chin and lip shape, and maxillary tooth exposure. The sella-nasion (S-N) plane and Frankfort horizontal (FH) plane have traditionally been used as horizontal planes of reference for various cephalometric and clinical assessments. However, patients do not carry their heads with the S-N or FH planes parallel to the floor. Cephalometric landmarks should not dictate head posture used for facial assessment and treatment planning. The clinical evaluation should therefore be carried out with the head in the natural posture.

Frontal analysis

From the frontal view, it is particularly important to assess facial form; transverse dimensions; facial symmetry; the vertical relationship in the upper, middle, and lower thirds of the face; the lips; and the nose.

Facial form

The relationship between the facial width and vertical height has a strong influence on facial harmony. Facial form and harmony should also be correlated with the patient's overall body build. When correcting facial form, the overall body build of the individual should be considered (ie, short and stocky versus long and thin). The height-to-width proportion of the face is 1.3:1 for females and 1.35:1 for males. The bigonial width should be approximately 30% less than the bizygomatic dimension (Fig 2-5). Short, square facial types are often associated with a Class II deep bite malocclusion, vertical maxillary deficiency, masseteric hyperplasia, and macrogenia, whereas long, narrow facial types are often associated with vertical maxillary excess, a narrow nose, mandibular anteroposterior deficiency, microgenia, a high palatal vault, and an anterior open bite malocclusion (Figs 2-6 and 2-7; Table 2-1).

Transverse dimensions

The rule of fifths is a convenient method for evaluating transverse facial proportions. The face is divided into five equal parts—each the approximate width of the eye—from helix to helix of the outer ears (Fig 2-8).

The outer fifths are measured from the center helix of the ears to the outer canthus of the eyes. Prominent ears may have a profound effect on facial proportions and can be corrected by otoplasty. In patients with masseter hypertrophy, the face appears square, and the gonial angles fall well outside the canthus line. A more harmonious facial form can be established in these patients by means of bilateral reduction of the masseter muscles and contouring the mandibular angles (Fig 2-9). Intergonial width can be increased by subperiosteal angle implants (Fig 2-10).

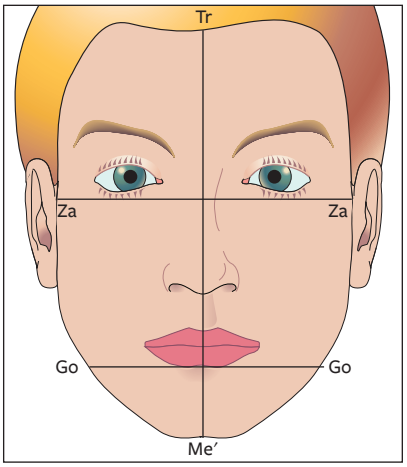


Fig 2-5 Facial form. The facial height (trichion [Tr]–soft tissue menton [Me′]):bizygomatic width (Za-Za) should be 1.3:1 (females) and 1.35:1 (males). The bigonial width (Go-Go) should be approximately 30% less than the bizygomatic width.

Fig 2-6 In this individual, the bigonial width is greater than the bizygomatic width because of bilateral masseter muscle hypertrophy.

Fig 2-7 Individual with a long, narrow face. The bizygomatic width is more than 30% greater than the bigonial width.

Table 2-1 | Comparison of broad and narrow faces

	Broad face	Narrow face
Facial height	Square, short	Long
Bigonial width	Masseter hypertrophy	Decreased intergonial distance
Nose	Broad nose	Narrow nose
Chin	Macrogenia	Microgenia

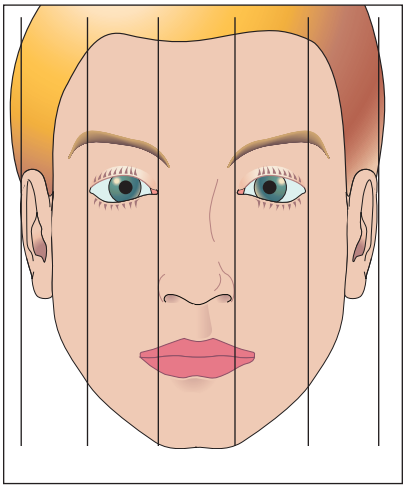


Fig 2-8 Transverse facial proportions.

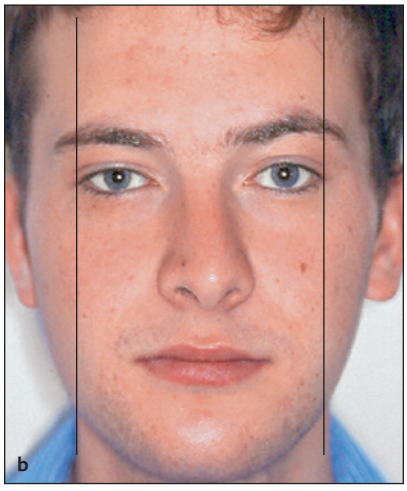


Fig 2-9 (*a*) The bigonial width is increased because of bilateral masseter muscle hypertrophy. The gonion falls lateral to a vertical line drawn through the outer canthus of the eye. (*b*) Transverse facial harmony has been restored by bilateral masseter muscle and mandibular angle reduction.

Fig 2-10 (*a*) This patient wanted to make his oval face more square. (*b*) The angles of the mandible were augmented by the placement of bilateral subperiosteal angle implants.

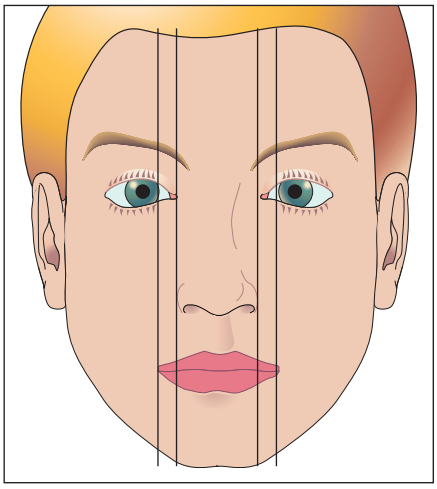


Fig 2-11 Vertical lines drawn through the medial canthi should coincide with the ala of the nose, whereas vertical lines drawn through the medial margins of the irises of the eyes should coincide with the corners of the mouth.

The medial three-fifths of the face are measured from the outer to the inner canthus of the eyes. The outer border should coincide with the gonial angles of the mandible. In patients with masseter muscle hypertrophy, the gonial angles will fall well lateral to this line (see Fig 2-9a). In patients with long faces, there will be a tendency for the gonial angles to be medial to these lines. It should be noted that the width of the mouth should approximate the distance between the inner margins of the irises of the eyes (Fig 2-11).

The middle fifth is delineated by the inner canthus of the eyes. In patients with hypertelorism, this fifth will be out of proportion with the other four-fifths. The ala of the nose should coincide with these lines (see Fig 2-11). For patients in whom maxillary advancement and/or superior repositioning is considered and the ala falls outside of the lines, control of alar width is indicated during surgery (see chapter 5).

Facial symmetry

To assess facial symmetry, an imaginary line is drawn through the soft tissue glabella (G′), pronasale (Pn), center of the philtrum of the upper lip and lower lip, and soft tissue pogonion (Pog′; Fig 2-12). For more accurate assessment, these points should be marked on the patient's face one at a time while other parts of the face are blocked out.

The maxillary and mandibular dental midlines should be assessed in relation to the facial midline, as well as in relation to each other. These observations will play an important role in the decision-making process regarding surgical or orthodontic correction of dental midlines. It is also important to evaluate the mandibular dental midline in relation to the midline of the chin. This information will assist in treatment planning for correction of mandibular asymmetry by means of mandibular surgery, genioplasty, or both. The presence of a transverse cant in the occlusal plane should be noted and correlated with the asymmetry. Surgical correction of an occlusal plane cant will often play a significant role in the total correction of facial asymmetry and should not be corrected orthodontically (see chapter 4).

No face is perfectly symmetric, but the absence of any obvious asymmetry is necessary for good facial esthetics. Posteroanterior cephalometric radiography or CBCT imaging for 3D virtual treatment planning are indicated in the presence of a clinically significant asymmetry. This will allow the clinician to distinguish between bone, soft tissue, or a combination of the two as etiologic factors.

Vertical relationship

In the vertical dimension, the face can be divided into three equal parts (Fig 2-13): (*1*) upper third (hairline [trichion] to the glabellar area), (*2*) middle third (glabellar area to subnasale [Sn]), and (*3*) lower third (Sn to soft tissue menton [Me′]).

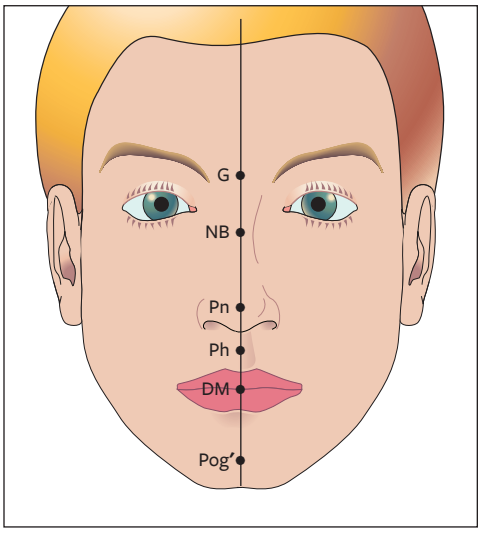


Fig 2-12 Facial symmetry. Important midline structures are the midpoint between the eyebrows (G), nasal bridge (NB), nasal tip (Pn), midpoint of the philtrum of the upper lip (Ph), dental midlines (DM), and midpoint of the chin (Pog′).

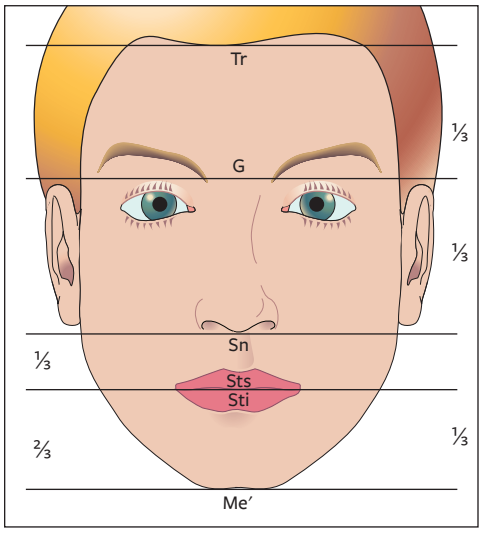


Fig 2-13 The face is divided into thirds by drawing horizontal lines through the trichion (Tr), G, subnasale (Sn), and soft tissue menton (Me′). The lower third can be divided into an upper third (from Sn to stomion superius [Sts]) and a lower two-thirds (from stomion inferius [Sti] to Me′).

Table 2-2 | Comparison of excessive and deficient midface dimensions

	Excessive middle third	Deficient middle third
Vertical maxillary dimension	Excessive	Deficient
Cheeks	Sallow	Full
Sclera showing	Visible below the iris	Normal
Cheekbones	Flat	Prominent, broad
Paranasal areas	Flat	Full
Nose	Narrow, long	Short, broad

Upper third of the face

Fortunately, deformities that exist in the upper third of the face can usually be masked by an appropriate hairstyle. However, it is important to record deformities in this area because they may indicate craniofacial deformities.

Middle third of the face

The nose, center of the lips, and middle of the chin (in the lower third of the face) should fall along a true vertical line (Table 2-2). Generally, no sclera is seen above or below the iris in a relaxed eyelid position with the patient looking straight ahead in natural head posture. Individuals with a midface deficiency tend to show sclera below the iris of the eye (Fig 2-14).

Sequential evaluation of the cheekbones, paranasal areas, alar eminences, and upper lip relation (in the lower third) should be performed. The cheekbone–nasal base–lip contour is a convenient contour line to evaluate the harmony of the structures of the midface (zygoma, maxilla, and nasal base) with the paranasal area and upper lip. This line starts just anterior to the ear, extends forward through the cheekbone, and then runs anteroinferiorly over the maxilla adjacent to the alar base of the nose, ending lateral to the commissure of the mouth. The line should form a smooth, continuing curve (Fig 2-15). An interruption of the curve may be an indication of an apparent skeletal deformity. Figure 2-16 illustrates a clear interruption of the line in the maxillary area, indicating maxillary antero-

Fig 2-14 Sclera shows below the irises of the eyes in this individual with midface deficiency.

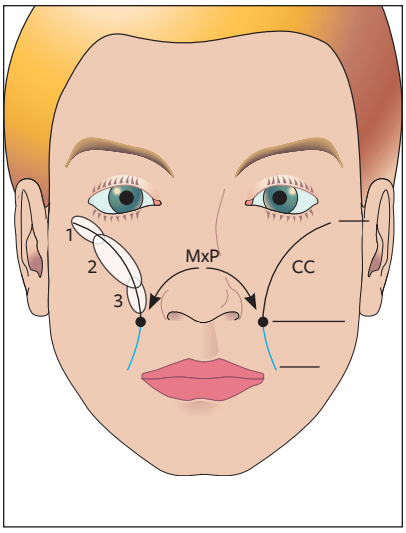


Fig 2-15 Cheekbone–nasal base–lip contour. The cheekbone area (CC) is divided into three parts: (1) zygomatic arch, (2) middle area, and (3) subpupillary area. The maxillary point (MxP) is the most medial point on the curve. The nasal base–upper lip contour (blue) extends inferiorly from MxP. The line should curve gently, without interruptions, ending lateral to the corner of the mouth.

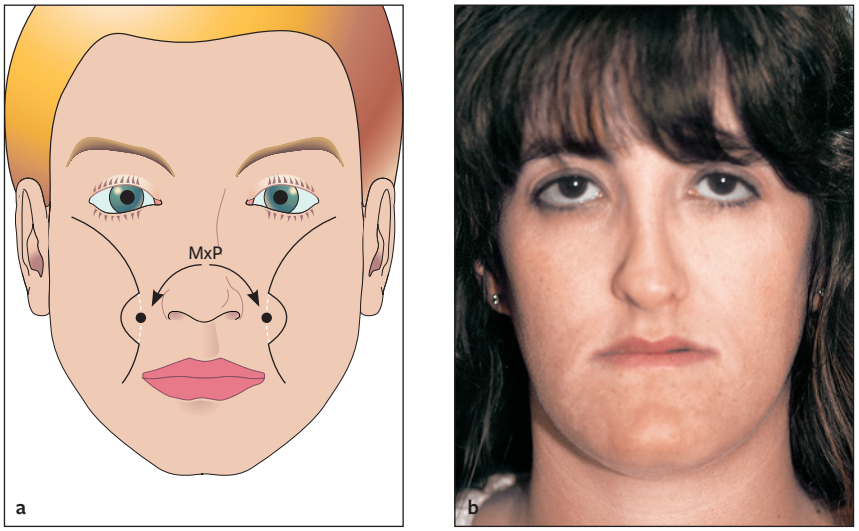


Fig 2-16 (*a*) Interruption of the curve at MxP. (*b*) Individual with maxillary anteroposterior deficiency. There is an interruption in the cheekbone–nasal base–lip contour at MxP.

posterior deficiency. In Fig 2-17, there is a double break with one indicating maxillary deficiency and the other an interruption in the lower part because of mandibular anteroposterior excess.

Lower third of the face

The middle third to lower third vertical height of the face should have a 5:6 ratio (Table 2-3). The length from Sn to stomion superius (Sts; called the *upper lip length*) should

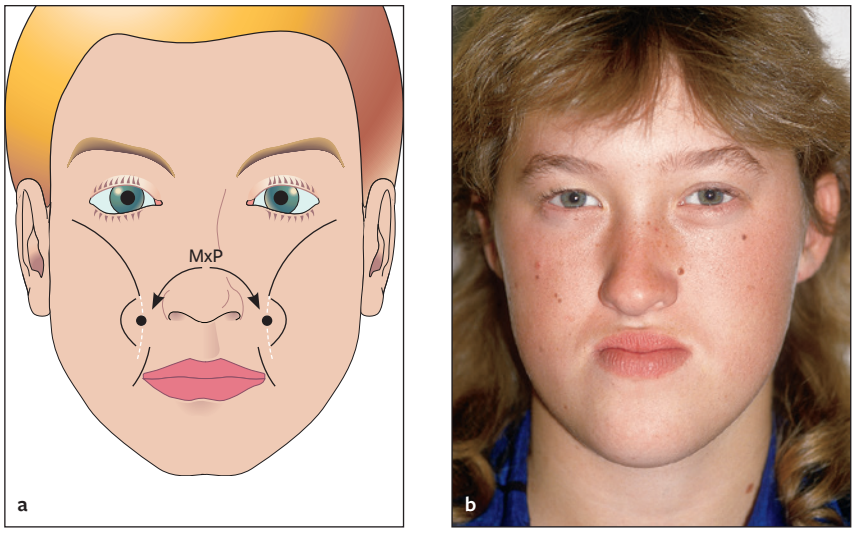


Fig 2-17 (*a*) Interruption of the curve at MxP and below MxP. (*b*) An individual with maxillary antero-posterior deficiency and mandibular prognathism. The cheekbone–nasal base–lip contour is interrupted with a double break, at MxP and also below MxP.

Table 2-3 | Comparison of excessive and deficient lower face height

	Excessive lower third	Deficient lower third
Vertical maxillary dimension	Excessive	Deficient
Lip appearance	Increased interlabial gap	Overclosed
Smile	Gummy	Toothless
Maxillary incisor exposure	Excessive	Little or none
Chin	Microgenia	Macrogenia
Malocclusion	Class II with or without anterior open bite	Class III closed bite or Class II deep bite

make up one-third of the lower third facial height. The distance from stomion inferius (Sti) to Me′, the *lower lip length*, should equal two-thirds of the lower third face height (see Fig 2-13).

Normal upper lip length is 20 ± 2 mm for females and 22 ± 2 mm for males, measured from Sn to upper lip inferior (Sts). If the upper lip is anatomically short, there is a tendency for the interlabial gap to be larger than normal and for increased maxillary tooth exposure with normal lower facial height. This condition should not be confused with skeletal vertical maxillary excess. The distance from lower lip superior (Sti) to Me′ is 40 ± 2 mm for females and 44 ± 2 mm for males. The lower lip may often appear short because of posture caused by maxillary incisor interference in patients with deep bite. The upper lip length should be related to lower anterior dental height.

With the patient's lips in repose, the amount of maxillary incisor exposure beneath the upper lip should be noted (Fig 2-18). For individuals in whom the maxillary incisors are not visible under the upper lip, the tooth-lip relation should be evaluated with the mandible rotated open until the lips just separate (Fig 2-19). The relation of the dental

Fig 2-18 Excessive maxillary incisor exposure and increased interlabial gap. Normal maxillary incisor exposure under the upper lip is 1 to 4 mm. This measurement will be influenced by upper lip length, vertical maxillary length, lip thickness, and the angle and anteroposterior position of the maxillary incisors.

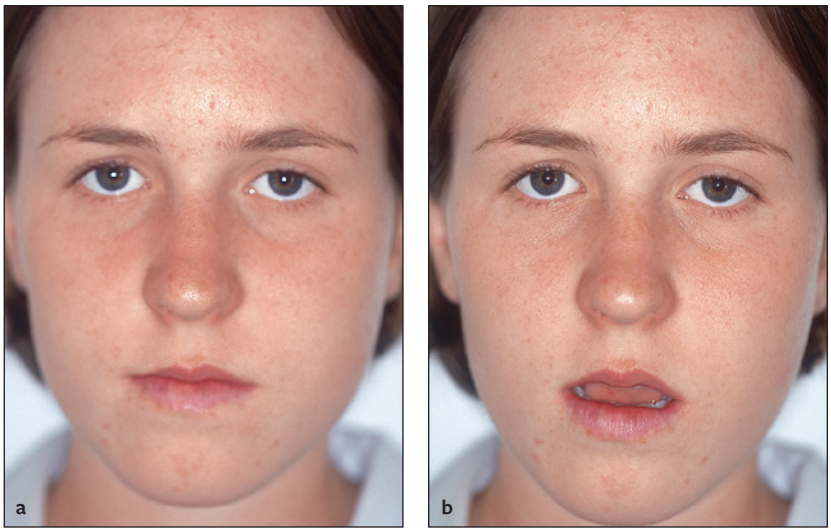


Fig 2-19 Individual with vertical maxillary deficiency. (*a*) It is not possible to assess maxillary incisor–lip relationship with the teeth in occlusion. (*b*) The lack of maxillary incisor exposure is evident with the mandible rotated open until the lips part and the upper lip is relaxed and not influenced by the lower lip.

midline to the facial midline is an important aspect to note because dental midlines can be coordinated and/or corrected either orthodontically or surgically. The etiology of dental midline shifts may be dental or skeletal. Dental factors that may cause midline shifts include spaces; missing teeth; tooth rotations; malpositioned teeth; crowding; crowns, fixed partial dentures, fillings, or implants (which can all change the size of teeth); and tooth size discrepancy.

In faces with asymmetry involving the mandible, it is critical to note the midline of the chin and its relation to the mandibular dental midline. The chin is evaluated for symmetry, vertical relation, and shape. The cant of the occlusal plane is evaluated, especially in individuals with facial asymmetry, by asking the patient to bite on a wooden spatula and then relating the occlusal plane to the interpupillary line (Fig 2-20). The maxillary dental arch level (between the maxillary canine tips) must be distinguished from the mandibular dental arch level (between the mandibular canine tips). However, with this assessment it is necessary to make sure that the orbits are on a horizontal plane because there may be an orbital deformity influencing this observation. Patients who present with facial asymmetry and a cant in the occlusal plane will require an anteroposterior cephalometric radiograph for further analysis.

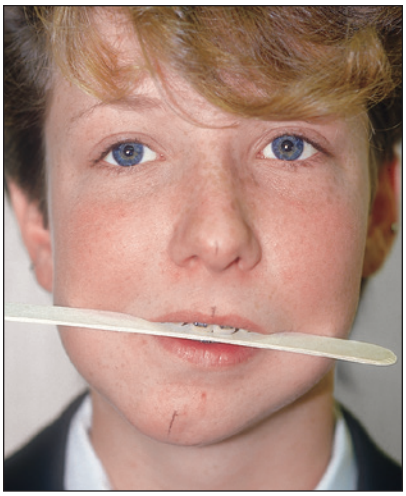


Fig 2-20 The cant in the occlusal plane can be evaluated in relation to the interpupillary line by asking the patient to bite on a wooden spatula. During this assessment, make sure that the interpupillary line is parallel to the floor.

The amount of gingiva exposed during smiling is also noted. The ideal tooth exposure during smiling is the full tooth crown to 2 mm of gingiva, which occurs in females more often than males. When examining the smile, it should be kept in mind that the amount of tooth exposure is influenced by (*1*) the vertical length of the maxilla, (*2*) lip length, (*3*) maxillary incisor crown length, (*4*) amount of lip action with smile, and (*5*) shape of Cupid's bow of the lip.

Surgical superior repositioning of the maxilla is indicated only when excessive gingival exposure is found in combination with an increased interlabial gap, increased maxillary incisor exposure, and increased vertical height of the lower third of the face. The amount of surgical superior repositioning will be dictated by the amount of tooth exposure, lip length, crown length, and age and sex of the patient. Keep in mind that superior repositioning of the maxilla will tend to shorten the upper lip. The upper lip will lengthen with age, especially in males. If necessary, surgical repositioning should err on the long side because overcorrection gives the patient a toothless and aged look.

One should never plan treatment based on the smile pattern. For example, an individual may exhibit a normal maxillary tooth–lip relationship (1 to 4 mm) that increases during smiling to expose up to 7 mm of gingiva ("gummy smile"). If superior repositioning is planned according to the amount of gingiva exposed during smiling, the maxilla will need to be superiorly repositioned by 6 mm to establish the ideal full tooth exposure. However, this will result in no tooth exposure and a toothless look in repose.

Lips

The lips are extremely critical to overall esthetics. Lip symmetry should be evaluated; if asymmetry exists, its etiology should be determined (eg, cleft lip, facial nerve dysfunction, underlying dentoskeletal asymmetry, scarring caused by previous trauma, or congenital unilateral microsomia or macrosomia).

The lower lip generally exhibits 25% more vermilion than the upper lip, and the lips should be 0 to 3 mm apart in repose. An increased overjet will result in an everted lower lip and excessive vermilion exposure due to the effect of the maxillary incisors on the lip. There are specific racial differences in lip thickness and shape that one must bear in mind for the purposes of treatment planning. To accurately evaluate the maxillary incisor–lip relationship in patients with closed bites, the lips should be relaxed and the jaws moved apart until the lips are slightly parted (closed bites may be the result of maxillary vertical deficiency or severe deep bites). Accentuation of Cupid's bow of the upper lip may lead to exposure of the maxillary central incisors only. This exposure of the maxillary central incisors will not be evident on a lateral cephalometric radiograph because only the central incisors can be seen. Therefore, the amount of superior repositioning of the maxilla in patients with vertical maxillary excess should be assessed clinically and not radiographically.

Nose

Although the nose has not always been considered part of orthognathic correction, it comprises an important aspect of the overall facial esthetics, and the form and function of the nose can be affected by orthognathic surgery. Many orthognathic surgeons also perform rhinoplasty as part of overall dentofacial correction. In many instances, nasal reconstruction may be part of the orthognathic treatment plan; sometimes, rhinoplasty and orthognathic surgery can be performed simultaneously. Control of the nasal form should also be considered, especially in patients requiring superior repositioning and/or advancement of the maxilla (see page 292.)

The functional and esthetic nasal evaluation should be included in the examination of the orthognathic patient. An intranasal examination should be performed to identify a possible existing deviated nasal septum, hypertrophied turbinates, or nasal polyps. Esthetic concerns should be noted, and the nose should be evaluated from a frontal and profile view.

A discussion of detailed esthetic parameters of the nose is beyond the scope of this text. However, important esthetic factors to consider are the width of the nasal base, the distance from the base of the nose to the anterior extent of the nares, and from the anterior aspect of the nares to the tip of the nose. The prominence of the dorsum, the shape of the nasal tip, and the acuteness of the supratip break must also be considered in relation to the intended orthognathic surgery and the physical and/or relative esthetic effects surgery may have on these structures. The length of the columella and the nasolabial angle as well as the projection and shape of the nares should be considered; these aspects may be negatively affected by maxillary surgery.

Because orthognathic surgery can have a relative and anatomical effect on nasal form and esthetics, simultaneous rhinoplasty and orthognathic surgery should be limited to small corrections to the nasal dorsum only. Formal rhinoplasty should be deferred to a second procedure. Figure 2-21 demonstrates the profound relative change of the nose following orthognathic surgical correction of a Class III malocclusion.

Although the face is divided into equal thirds to simplify clinical examinations and for schematic descriptive purposes, an orthognathic surgical procedure may affect the soft tissue in one or more of these thirds. Ferretti and Reyneke described the division of the face from the frontal view into five areas of surgical influence (Fig 2-22).

Fig 2-21 Corrective facial changes following orthognathic surgery may have a profound relative and/or anatomical effect on the nose. (*a*) Preoperative view showing a nose that appears large with a prominent dorsum. (*b*) The nose appears to have a normal shape and form following correction of a Class III occlusion by superior repositioning of the maxilla via a Le Fort I osteotomy, mandibular setback by means of a bilateral sagittal split osteotomy, and advancement genioplasty.

Profile analysis

Upper third of the face

The supraorbital rims normally project 5 to 10 mm beyond the most anterior projection of the globe of the eye. Frontal bossing, supraorbital hypoplasia, exophthalmos, or enophthalmos should be distinguished.

Middle third of the face

It is helpful to examine the middle and lower thirds of the face in isolation, and masking the lower third with a card eliminates any undue influence that this third may have on the perceptions of the face as a whole. The middle third of the face can also be blocked out to evaluate only the lower third in relation to the rest of the face (Fig 2-23). The nose, cheeks, and paranasal areas are sequentially evaluated.

Nose

The shape of the dorsum is noted as normal, convex, or concave. The projection of the nasal bridge should be anterior to the globes (5 to 8 mm). The appearance of the nasal tip is evaluated for the presence of a supratip break and for tip definition and projection (Fig 2-24). It is important to distinguish between a dorsal hump and a turned-down tip because each has different treatment implications. The possible effect of maxillary surgery on the nose should be kept in mind when evaluating the proportions of the base of the nose (Fig 2-25).

Cheeks

The globes generally project 0 to 2 mm ahead of the infraorbital rims, whereas the lateral orbital rims lie 8 to 12 mm behind the most anterior projection of the globes (Fig 2-26). The cheeks should exhibit a general convexity from the apex of the cheekbone to the commissure of the mouth. This line of convexity, called the *cheekbone–nasal base–lip curve contour*, requires simultaneous frontal and profile examination. This line starts just anterior to the ear, extending forward through the cheekbone, then anteroinferiorly over the maxilla adjacent to the alar base of the nose, and ending lateral to the commissure of the mouth (Fig 2-27). The line should form a smooth, continuing curve with no interruptions. An interruption of the curve may indicate an apparent skeletal deformity. Figure 2-28 illustrates a clear interruption of this line in the maxillary area, indicating maxillary anteroposterior deficiency. In Fig 2-29, the interruption in the line is in the maxillary area, indicating maxillary anteroposterior deficiency, and inferior to the upper lip section, indicating mandibular anteroposterior excess.

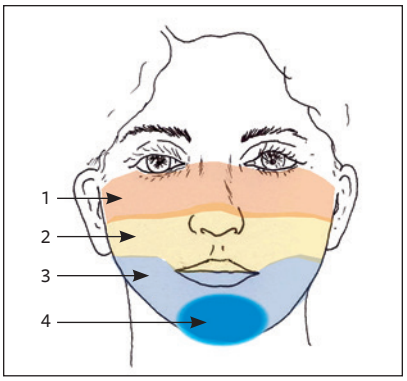


Fig 2-22 The face can be divided into oculonasal (1), maxillary (2), and mandibular (3) complexes. The mandibular complex includes the genial subcomplex (4).

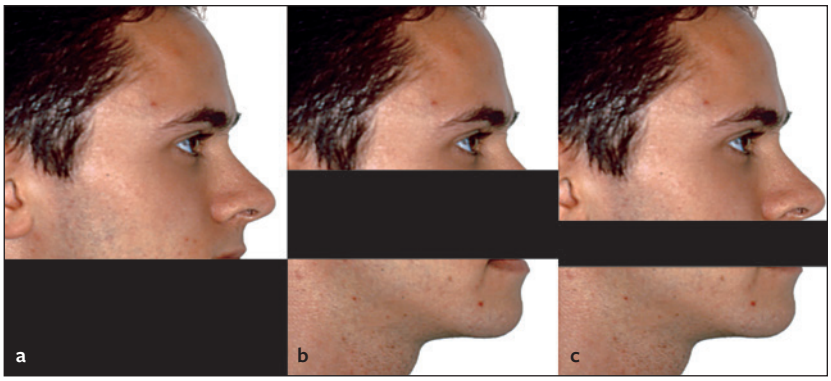


Fig 2-23 (*a*) The mandibular complex (including the chin) is blocked out, revealing the deficient paranasal flattening and poor upper lip support. (*b*) The middle third of the face is blocked out, showing the mandible and chin in good relation to the rest of the face. This observation is confirmed when only the upper lip and maxilla are blocked out (*c*).

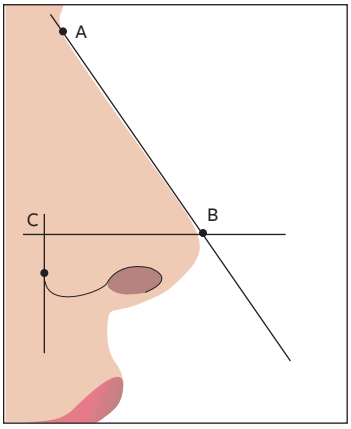


Fig 2-24 The nasal tip projection is evaluated by the Goode method. If BC is greater than 55% to 60% of AB, the nasal tip usually appears disproportionately overprojected.

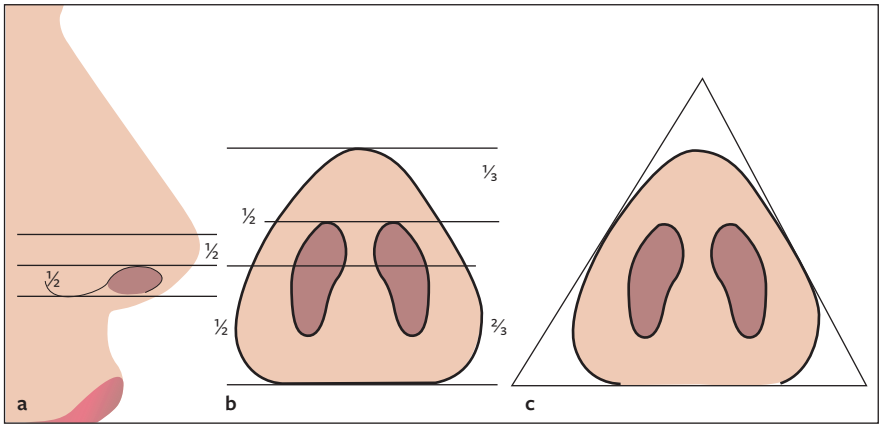


Fig 2-25 (*a*) Vertical ala–columella relationship. (*b*) Columella-lobule relationship with a ratio of approximately 2:1. (*c*) The general shape of the alar base should resemble an isosceles triangle, with the lobule neither too broad nor too narrow.

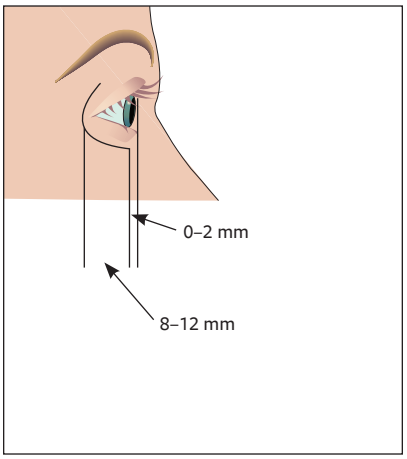


Fig 2-26 The lateral orbital rim lies 8 to 12 mm behind the globe, and the globe projects 0 to 2 mm ahead of the infraorbital rim.

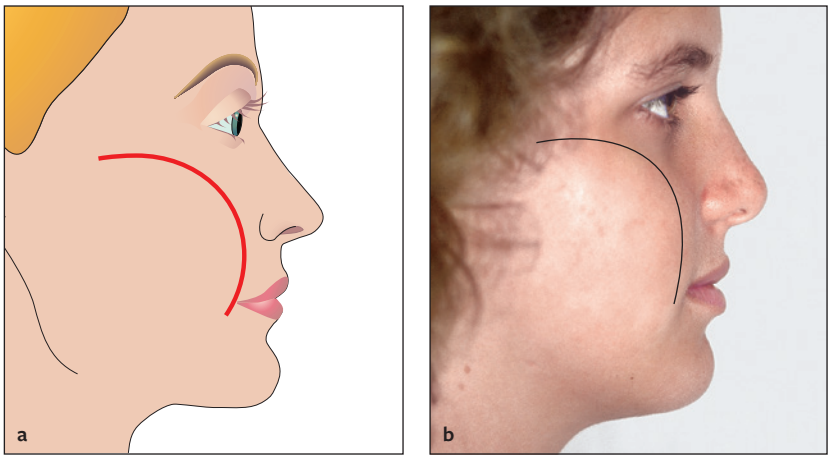


Fig 2-27 (*a*) Cheekbone–nasal base–lip curve contour. (*b*) Note the smooth, uninterrupted curve of the contour line in an individual with good facial proportions.