Diagnosis and Planning in Orthognathic Surgery

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66.1 Introduction

Over the last four decades, the scientific foundations for the art of changing facial appearance and improving orofacial function through orthognathic surgery were laid, and the value of treatment to improve lives is undisputed. The main treatment objective is currently not limited to achieving short-term improved occlusal function but also enhanced facial aesthetics and an open airway. Orthognathic surgery requires the combined skills of the specialities of orthodontics and oral and maxillofacial surgery; however, there remain major limitations relating to the uneven geographical distribution of experienced dedicated clinicians and financial barriers to the correction of dentofacial deformities. The treatment of some malocclusions combined with mild skeletal disharmony is possible by orthodontic compensation of the dentition with compromised facial aesthetics. Borderline cases therefore require meticulous assessment before finally deciding on orthodontic treatment alone or a combination of orthodontics and surgery as treatment approach.

Most compromised treatments lead to suboptimal results such as:

- Dental instability
- Skeletal instability
- Poor facial aesthetics
- Airway problems
- Periodontal problems

Which treatment plan to adopt should be discussed with the patient (and perhaps the parents or spouse) and all the advantages and disadvantages of each approach explained. The decision may also be influenced by factors such as the orthodontist's experience, financial insurance cover, available surgical expertise, and the patient's attitude and preferences [1].

Patients with dentofacial deformities are treated with four prime goals in mind:

1. *Function.* Apart from establishing normal masticatory function, the clinicians should also consider other problems caused by an abnormal jaw relationship such as speech defects, sleep apnea, attrition of the teeth, periodontal problems, and temporomandibular joint problems.
2. *Stability of results*. Definitive orthognathic treatment is a change for life, and it is important to achieve dental and skeletal stability following treatment.
3. *Aesthetics.* Facial appearance is often the patient's main concern, but patients are often reticent to voice these concerns. However, the surgeon should resist the temptation to determine unilaterally what a patient's aesthetic concerns are but should encourage the patient to express these.
4. *Airway.* The impact of jaw malalignment (and its correction) on the patency of the upper airways is a relatively recent addition to the treatment considerations in patients with dentoskeletal malocclusion. The support of the retropharyngeal soft tissues is determined to a large degree by the position of the anterior osseous attachments. Inadequate support for

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these soft tissues will contribute greatly to the development of sleep apnea especially as soft tissue laxity develops with aging. This consideration may influence treatment decisions particularly in Class III malocclusion. For example, we may be loath to unduly setback a mandible in a young adult due the future potential for sleep apnea development. Thus, in double jaw surgery, a treatment plan that favors greater maxillary advancement or in a single jaw surgery case a maxillary advancement may be preferable to a mandibular setback. These considerations add a further layer of complexity to the treatment algorithm as airway considerations may mean a compromise of aesthetics and vice versa [2, 3].

66.2 Systematic Aesthetic Facial Evaluation

The clinical assessment of the face is the most valuable of all diagnostic procedures and should be performed in a systematic fashion. The facial examination should start at the first instant a clinician meets the patient and continues during the initial informal discussion. During this period the patient is not self-aware, and facial function and features will be at their most natural. The focused facial examination follows and should be done while the patient is seated comfortably in natural head posture, the teeth in centric occlusion and the lips relaxed. The goal of the facial examination is to determine what components of the face are detracting from facial harmony and what functional problems may accompany the malocclusion and to make a tentative diagnosis.

It is helpful to structure the facial examination into frontal and profile views [4].

66.2.1 Frontal View

Facial appearance when viewed from the front is, not surprisingly, what a patient will value most.

A helpful first step is to assess the facial form.

- Facial form (Fig. 66.1a–h)—The relationship between the facial width and height has a strong influence on facial harmony. The ratio of facial width to facial height is more important than absolute values in establishing the overall facial type. Attractive faces tend to have proportions that fall within normative values. When evaluating facial form, the overall body build of the individual (corporo-facial relationship) should be considered (i.e., short and stocky versus long and thin). The height-to-width proportion (trichion to menton: bizygomatic width) is 1.3:1 for females and 1.35:1 for males. The bigonial width should be approximately 30% less than the bizygomatic dimension, and the width and shape of the chin should form a harmonious part of the overall facial contour. Leptoprosopic faces (long and narrow) are often associated with vertical maxillary excess, a narrow nose, mandibular anteroposterior deficiency, narrow gonial angles, microgenia, a high palatal vault, and an anterior open bite (Fig. 66.1a–c), while dolichoprosopic faces (short and square) are often associated with vertical maxillary deficiency, masseter hyperplasia, wide gonial angles, macrogenia, and Class III deep bite malocclusions (Fig. 66.1d, e). Individuals from Asia often have round oval faces (Fig. 66.1f). Patients with mandibular deficiency often have a tapered facial lower facial third and microgenia (Fig. 66.1g, h).
- Transverse facial dimensions (Fig. 66.2)—In general terms the *rule of fifths* is a convenient method used to evaluate the transverse proportions of the face. The face is sagittally divided into five equal parts, each the approximate width of the eye, from helix of the outer ears.
  - *Outer fifths:* Is measured from the lateral helix of the ear to the lateral canthus and is an indication of the width of the ears. Bat ears can be camouflaged by an appropriate hairstyle; however, otoplastic surgical procedures are relatively atraumatic and can improve the facial appearance dramatically. Otoplasty can be performed at the same time as orthognathic procedures.
  - *Medial fifths:* 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 long and narrow faces, the gonial angles will fall medial to this line, while in patients with broad and square faces, the gonial angles will fall lateral to these lines. Within these fifths it should be noted that the distance between the inner margins of the irides of the eyes should be equal to the width of the mouth. Abnormal interpupillary and intercanthal distance are often observed in syndromic patients and can only be altered by means of craniofacial surgery.
  - *Middle fifth:* Is demarcated by the lines through the inner canthus of the eyes. In patients with hypertelorism, this fifth would be relatively larger than the others. The ala of the nose (alar base width) should coincide with these lines, while the nasal dorsum

Fig. 66.1 The relationship between the facial height and width influences facial harmony. The variations of facial form: (**a**) narrow, (**b**) long, (**c**) tapered, (**d**) square, (**e**) round, (**f**) oval, (**g**) sharp, and (**h**) pointed, are demonstrated

should be approximately half of the intercanthal distance. For patients in whom maxillary advancement and/or superior repositioning is planned, this measurement should be considered and surgical control of the alar base may be indicated.

- Vertical evaluation (Fig. 66.3)—By convention the face is divided into three parts by horizontal lines adjacent to the hairline (trichion) to the soft tissue glabella, the nasal base (subnasale), and the lower border of the chin (menton). An aesthetically pleasing face should have approximate equivalence of the three parts.
  - *Upper third:* Deformities in this third can fortunately often be masked by an appropriate hairstyle; however, it is important to record deformities in this area as they may indicate craniofacial syndromes.
  - *Middle third:* Generally, no sclera is seen above and below the iris in a relaxed eyelid position. Individuals with midface deficiency tend to show sclera under the iris of the eye and will tend to have a long narrow nose. The cheekbone-nasal base-upper lip-lower lip contour line is a convenient indicator of the harmony of the structures of the midface (zygoma, maxilla, and nasal base) with the paranasal area and upper lip. This imaginary line starts just anterior to the ear, extends anteriorly across the cheekbone, and then curves antero-inferior over the maxilla adjacent to the alar

base of the nose, ending lateral and slightly below the commissure of the mouth. The line should form a smooth, continuous curve (Fig. 66.4a, c). A skeletal deformity will cause an interruption of the curve, and the area of interruption in the line is often an indication of a specific underlying deformity (Fig. 66.4b).

– *Lower third:* (Fig. 66.3) The middle to lower third vertical height of the face should have a 5:6 ratio. In the well-balanced lower third of the face, the upper lip makes up one third, while the lower lip and chin composes the lower two thirds. Normal upper lip length is 20 ± 2 mm for females and 22 ± 2 mm for males and measured from subnasale to upper lip sto-

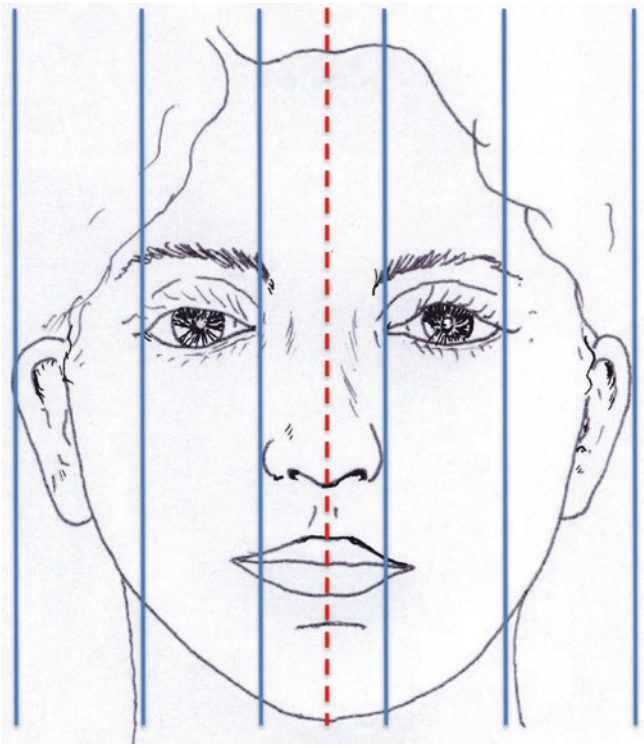

Fig. 66.2 Transverse facial proportions

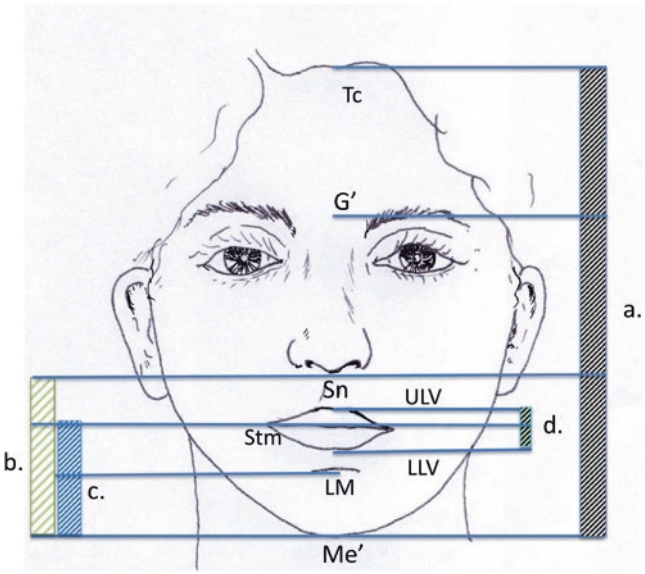

Fig. 66.3 Vertical facial proportions

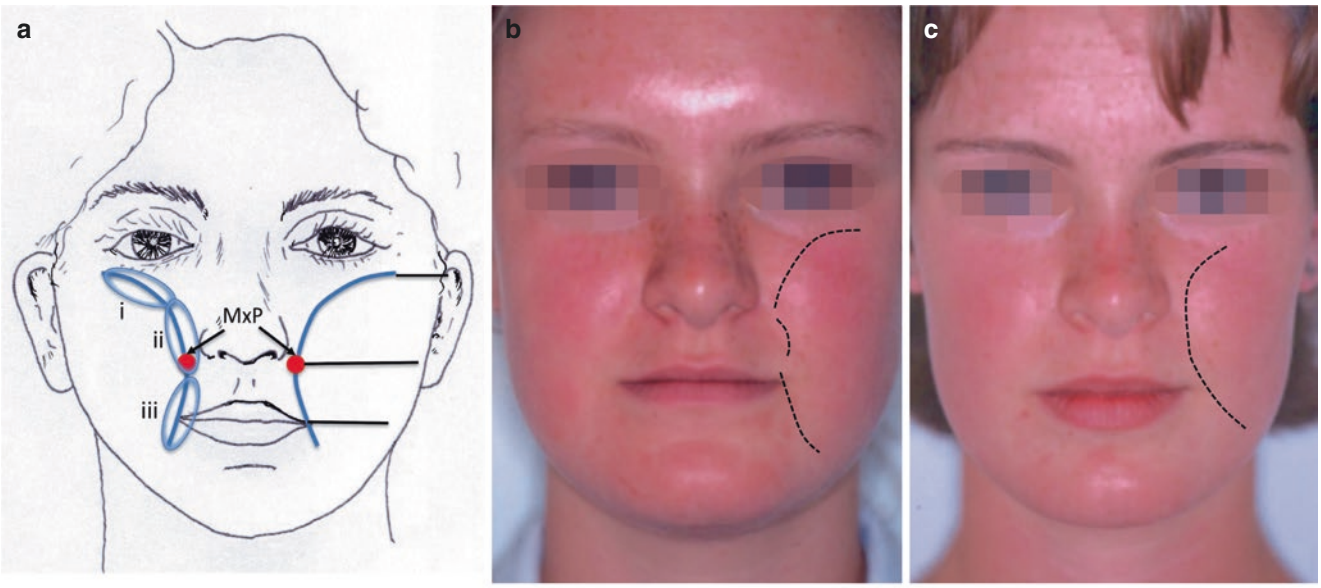

Fig. 66.4 (**a**) Cheekbone-nasal base-lip contour. (**b**) The interruption of the curve at MxP (maxillary plane) indicates maxillary anteroposterior deficiency. (**c**) Correction of the malocclusion establishes a smooth contour line

mion (stomion superius). When the upper lip is relatively short, there will be a tendency to an increased interlabial gap and excessive upper incisor exposure with normal facial height. This should not be confused with the same observations in patients with vertical maxillary excess (Fig. 66.8). Normal lower lip length is 40 ± 2 mm for females and 44 ± 2 mm for males. The lower lip may give the false impression of being short due to a deep bite. It is mandatory that the interlabial gap and tooth exposure be evaluated with the teeth in occlusion and the lips in repose (Fig. 66.8b). A gummy smile is not a definite indication of vertical maxillary excess as some patients may have a normal maxillary height but hyperactive upper lip when smiling. An increased interlabial gap (more than 3 mm), excessive upper incisor exposure (more than 4mm), and a gummy smile are typical characteristics of vertical maxillary excess (Fig. 66.9). For patients in whom the upper incisors are not visible under the upper lip, the tooth lip relationship should be evaluated with the mandible rotated open until the lips just separate (Fig. 66.8a). Lack of upper incisor exposure is indicative of vertical maxillary deficiency and usually occurs in combination with decreased lower facial height. The height of the lower face can also be influenced by the height of the mandible, and the height of the chin should be noted in any discrepancy in vertical facial height.

The arbitrary subdivision of the face into vertical thirds has a critical flaw. The effects of a deformity of one jaw and the correction thereof may stretch across two conventional facial thirds.

It is for this reason that the authors believe a more pragmatic approach to facial aesthetic assessment is to divide the face into zones of influence, i.e., zones which can be modified by orthodontics and orthognathic surgery.

The *Ferretti-Reyneke analysis* (Fig. 66.5) divides the face into five zones of influence, i.e., zones of soft tissue facial integument that are under the influence of the corresponding underlying skeleton:

- *The fore-head zone* (i). Extending from trichion (hairline) to a line connecting the eyebrows across glabella.
- *The oculonasal zone* (ii). Extending inferiorly from the eyebrow line to a line extending from the lower border of the zygomatic arch curving upward to the infraorbital foramen onto the nose above the supra tip break and continuing to the opposite side.

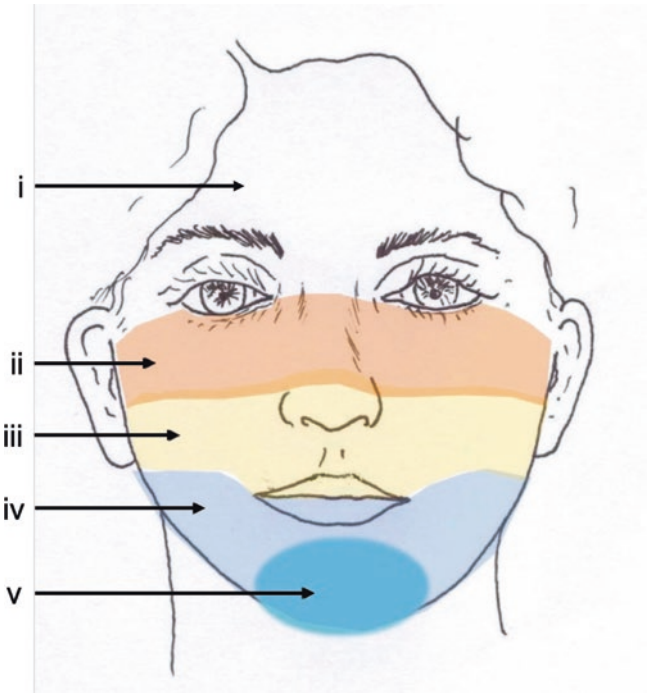

Fig. 66.5 The *Ferretti-Reyneke* analysis

- *The gnathic complex.* This subunit is subdivided into an upper *maxillary component* (iii) which extends from the lower aspect of the oculonasal complex to a curved line extending along the lower margin of the upper lip (or the incisal edge of exposed maxillary teeth) to the angle of the mouth and proceeding in a curvilinear fashion to the lower attachment of the auricle and a lower *mandibular component* (iv) which extends to the lower border of the mandible and contains in its anterior aspect the oval *mental subunit* (v) which delimits the soft tissue chin.

It is critical to remember that facial evaluation is not the search for deviation from the norm of a single subunit but the search for proportion. For example, a facial form diagnosed as vertically excessive means it is excessive in relation to its transverse dimension, *not* that it is longer than the norm. By increasing only the transverse or only the vertical dimension, facial harmony will be lost; however, harmony is re-established by increasing both the transverse and vertical dimensions.

Facial Symmetry

The facial midline is the reference line to evaluate the forehead (glabella), nasal dorsum, nasal tip, maxillary dental midline, columella of the nose, philtrum of the upper lip, mandibular dental midline, lower lip, and the chin (Figs. 66.2 and 66.6). In the initial overall assessment of facial asymmetry, we should establish whether the asymmetry involves

the chin, the mandible or the maxilla, or a combination of the structures. Careful assessment of an occlusal cant of the maxilla is mandatory as it will play an important role in the correction of the asymmetry. Soft tissue asymmetry, either primary or secondary to skeletal asymmetry, should be noted. Finally, symmetry of the nose, orbits, and forehead should be evaluated (Figs. 66.2 and 66.6).

The face is a three-dimensional structure, and the symmetry of the face will be influenced by deformities in the vertical, anteroposterior, and transverse planes. Clinical frontal assessment of the face is however the most critical, and discrepancies should be correlated with posterior facial asymmetry by noting any transverse, anteroposterior, and/or sagittal cants in the occlusal plane. The occlusal plane should be parallel to the interpupillary line, provided there is no orbital dystopia. Surgical correction of an occlusal plane cant often corrects facial asymmetry, and the severity of the cant should correlate with the dental and facial asymmetry. During treatment planning the clinicians should assess if orthodontic or surgical correction of dental midlines is required. With skeletal asymmetry the dental midline should not be orthodontically coordinated but rather aligned in the center of each jaw to allow surgical correction of the skeletal asymmetry. Keep in mind that no face is perfectly symmetric.

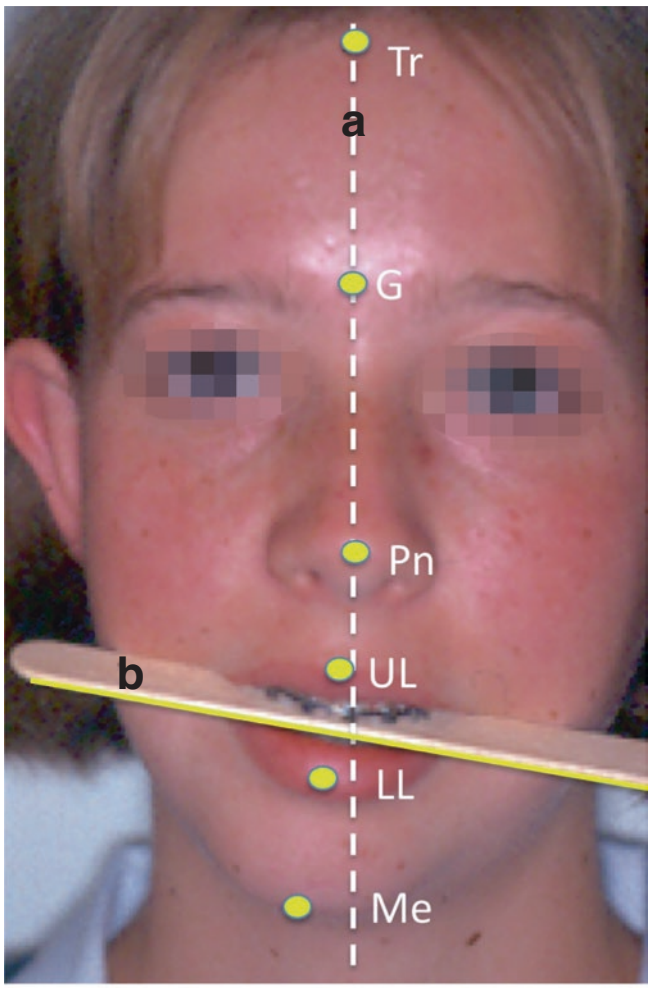

Fig. 66.6 The facial midline (**a**), and occlusal cant (**b**)

Lips

The lips play an extremely important role in the overall facial aesthetics, and careful assessment is required. Lip symmetry should be evaluated in the rest position as well as when the patient is smiling. Lip symmetry may be influenced by facial nerve dysfunction, underlying dentoskeletal deformities, scarring due to previous trauma, congenital clefting, microstomia, macrostomia, or hyperplasia. The lower lip generally exhibits 25% more vermillion than the upper lip. With the presence of an accentuated Cupid's bow, only the upper incisor may be visible under the upper lip and very little or even no lateral incisor (Fig. 66.7). An interlabial gap of 0 to 4mm and 1 to 4mm of upper incisor tooth exposure under the upper lip with the lips in repose are considered pleasing while the full crown of the incisor exposed when smiling.

Fig. 66.7 An increased interlabial gap with excessive amount of upper incisor exposure under the upper lip (**a**). A poorly shaped upper lip (distorted Cupid's bow) and excessive amount of vermillion excessive exposure (**b**)

Note any asymmetry of the lips when smiling (Fig. 66.10). When vertical skeletal or dental corrections are contemplated, the vertical relationship of all four incisors to the upper lip should be clinically considered. Only the upper central incisors are visible on a lateral cephalometric radiograph and should not be used to plan vertical maxillary changes (c in Fig. 66.13).

66.2.2 Profile View

Although it is emphasized that the clinical assessment of the face is mandatory, the cephalometric analysis of the lateral cephalometric radiograph has been the predominant method of profile evaluation. Many orthodontists are accustomed to using the quantitative data obtained from the lateral cephalometric analysis as the main diagnostic tool. The contemporary orthodontist and facial surgeon rely on facial proportionality and more subjective aesthetic evaluation criteria than linear and angular measurements. Treatment decisions should rather be made by what is most aesthetically appealing rather than by what the cephalometric norms indicate. The plethora of cephalometric values available can lead to confusion and unnecessary complexity. The undermentioned cephalometric measurements are the most useful indicators to confirm a clinical diagnosis.

Nasolabial Angle (a in Fig. 66.11)

The angle is measured between the columella of the nose and the upper lip and should be between 85° and 105°. It is influenced by the position and angle of the upper incisor teeth and the anatomy of the nasal columella. Excessive orthodontic retraction of the upper incisor teeth (i.e., com-

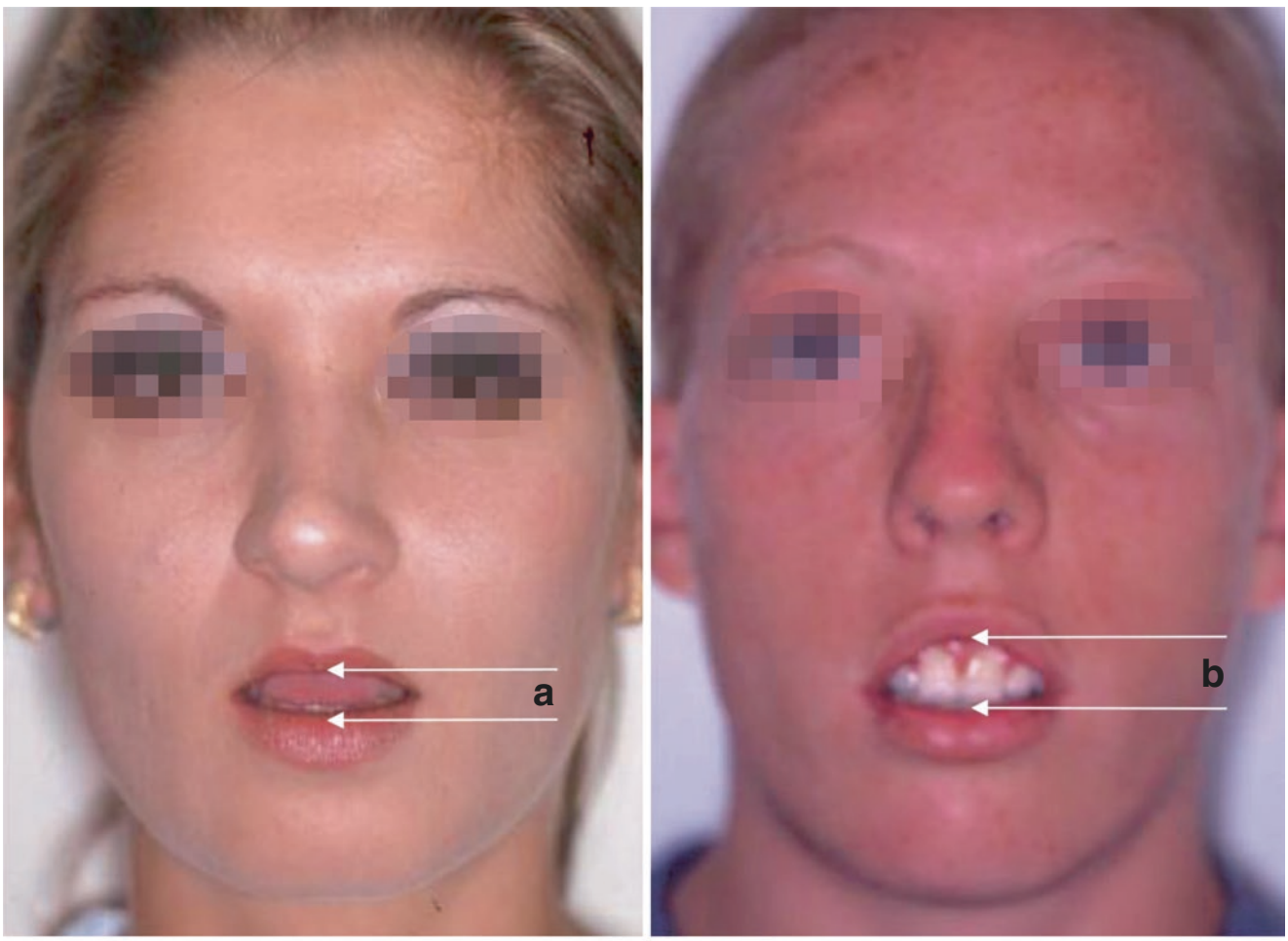

Fig. 66.8 No upper incisor exposure under the upper lip leads to a "toothless" look (**a**). An increased interlabial gap with excessive upper incisor exposure suggests vertical maxillary excess (**b**). The assessment should always be done with the lips in repose

Fig. 66.9 A patient with vertical maxillary excess. Note the increased interlabial gap with the lips in repose (**a**) and gummy smile (**b**)

promised treatment for a Class II occlusion) will lead to poor upper lip support and an increased nasolabial angle. This will often lead to early wrinkling and an aging appearance of the lip. An over-closed bite will cause an acute angle, while a hanging columella of the nose will increase the angle.

Labiomental Angle (b in Fig. 66.11)

This angle is formed by the intersection of the lower lip and chin measured at the soft tissue of the chin. The angle is a gentle curve and should be 120° ± 10°. The lower lip, the depth of the labiomental fold, and chin button should form a smooth and harmonious S-shaped curve with the labiomental fold dividing the chin into an upper third and lower two thirds. The angle is acute in patients with Class II dentoskeletal deformities due to the everted lower lip or patients with macrogenia. Individuals with Class III dentoskeletal deformities and the lower incisors retroclined (compensated) or patients with microgenia will exhibit an obtuse labiomental angle.

Lip-Chin-Throat Angle ((i) in Fig. 66.12)

The angle is formed between the lower border of the chin and a line connecting the lower lip and soft tissue pogonion. The chin and submental area are considered attractive with an angle between 100° and 120°.

Fig. 66.10 An asymmetric smile

Chin-Throat Length ((ii) in Fig. 66.12)

It is measured from the angle of the throat to the soft tissue menton. It is only meaningful when this angle is measured with the patient's head in natural posture. A length of between 38 and 48mm is considered to be normal and is significant when assessing mandibular length. This measurement is helpful for differentiating between mandibular anteroposterior excess and maxillary anteroposterior deficiency. For a patient with a Class III malocclusion and normal chin-throat length, maxillary deficiency should be suspected.

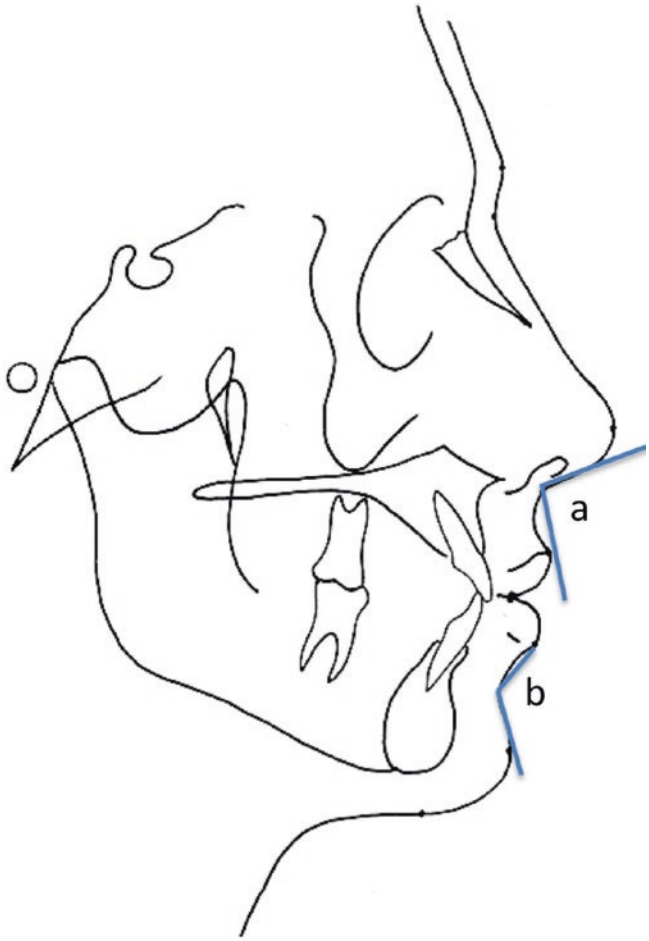

Fig. 66.11 (a) The nasolabial angle, measured between the inclination of the columella of the nose and the upper lip, should be 85°–105°. (b) Labiomental fold. The lower lip-chin angle should be 130°. However the general shape of the chin should be considered

Upper Lip Length (b in Fig. 66.13)

The length of the upper lip is measured from subnasale to the lower border of the upper lip (stomion superius) and should be 18–22 mm in females and 20–24 mm in males. This measurement should be performed with the lips in repose. During the planning of tooth-lip relationship, it should be kept in mind that the upper lip will increase in length with age.

Interlabial gap (d in Fig. 66.13)

The interlabial gap should be assessed with the lips in repose and the teeth in occlusion. It is measured between stomion superius and stomion inferius (0–4 mm). If the lips touch when the teeth are in occlusion, the upper incisor-lip relationship should be evaluated with the lower jaw rotated open until the lips are slightly apart.

Facial Contour Angle (e in Fig. 66.13)

This measurement will give the clinician an indication of facial convexity or concavity and is influenced by the anteroposterior relationship between glabella, subnasale, and menton. The angle is formed between the upper facial plane (glabella-subnasale) and lower facial plane (subnasale-pogonion). The angle is recorded above subnasale and expressed as negative when the angle is ahead of the upper facial plane (in convex profiles) and as positive when the angle is behind the upper facial plane (usually in concave profiles). A pleasing facial profile for females will have a facial contour angle of $-13° \pm 4°$ and for males $-11° \pm 4°$. This measurement will also be influenced by the height of the maxilla. The mandible will rotate counterclockwise (upward and forward) with vertical maxillary deficiency leading to a more concave profile, while it will rotate clockwise (downward and backward) with vertical maxillary excess leading to a more convex profile.

Nose (Fig. 66.14)

This important anatomic structure is situated in the middle of the face, and its important influence on facial aesthetics has often been neglected by orthodontists and maxillofacial surgeons in the past. More focus is placed on the aesthetic evaluation of the nose by the fact that the relative nasal aesthetics can be influenced by orthodontic treatment and certainly by orthognathic surgery. The fact that rhinoplasty is now considered to be part of the field of treatment for many orthognathic surgeons has certainly made the careful aesthetic evaluation of the nose an important consideration. In many cases nasal reconstruction will form part of the orthognathic treatment plan, and in some cases, reconstruction can be performed concurrently with orthognathic surgery. The authors prefer to defer most nasal reconstructions to 6 months after orthognathic surgery due to the substantial relative effects orthognathic surgery has on nasal aesthetic.

The amount of nostril show in profile view may be affected by either a hanging columella or retracted alae (Fig. 66.14a). The shape of the dorsum should be noted as normal, convex, or concave. It is important to distinguish between a large dorsum and a turned-down nasal tip as the treatment would be entirely different. The relationship between the lengths of the nasal dorsum and the projection

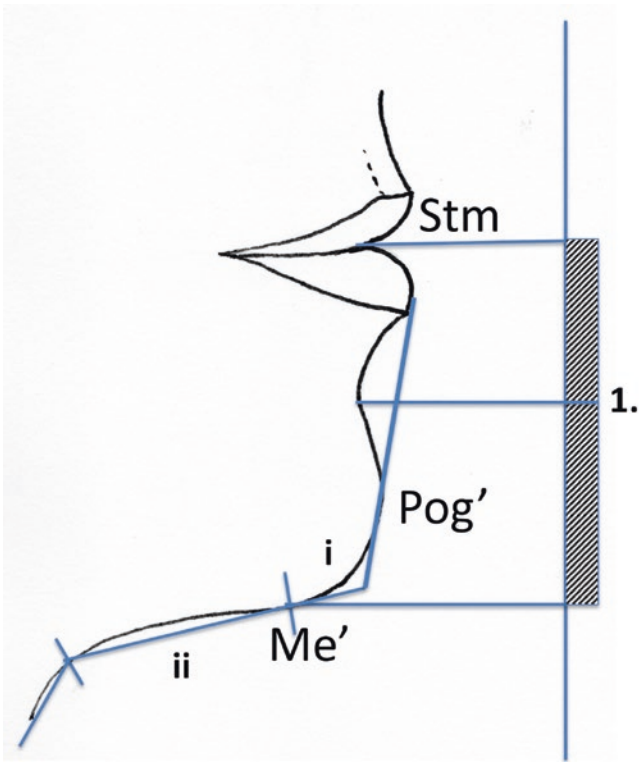

Fig. 66.12 The lip-chin-throat angle (i). Chin-throat length (ii)

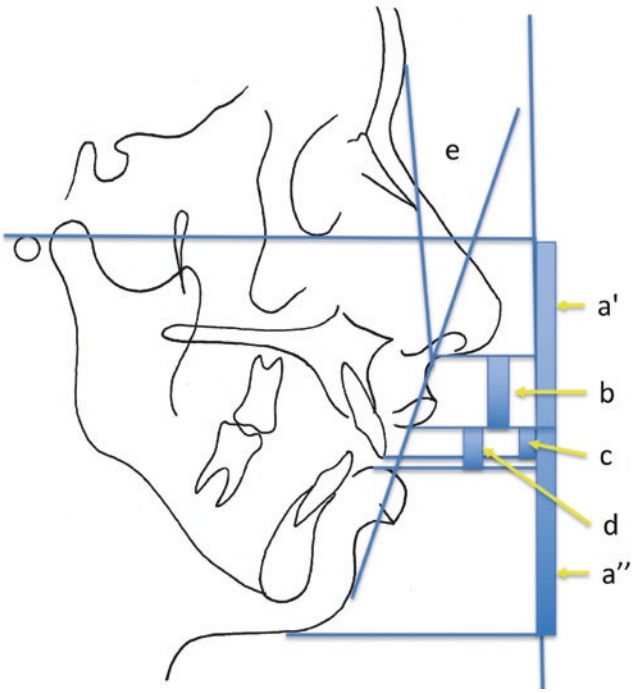

Fig. 66.13 Midface height (a'), lower facial height (a''), upper lip length (b), upper lip vermillion (c), interlabial gap (d), and facial contour angle (e)

of the nose can be evaluated by the method of Goode. According to Goode the length of the nose should be about 55–60% greater than the projection of the nose (Fig. 66.14b). From nasal base to the tip, the ratio of projection should be 1–2 (Fig. 66.14c). The nostrils and columella should be assessed from a "worm's eye" view (Fig. 66.14d). The nasal bridge should project about 5–8 mm in front of the globes of the eyes. The nasal tip should be noted as narrow, bulbous, asymmetric, or normal. The width of the nasal base, the acuteness of the supra tip break, the visibility of the nostrils,

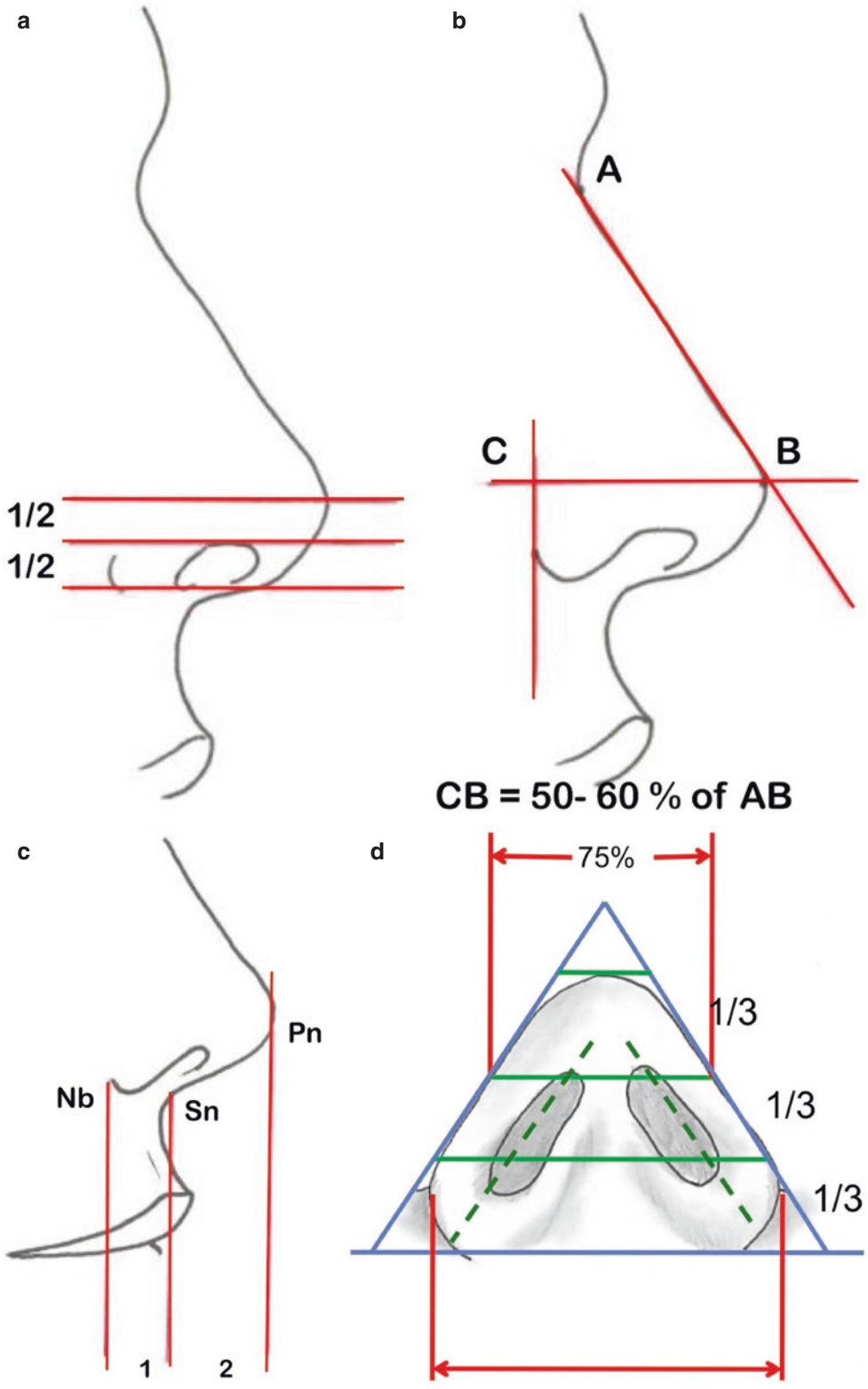

Fig. 66.14 Assessment of nostril show (**a**). Nasal projection (CB) to nasal length (AB), according to Goode's ratio: CB:AB = 0.55:0.6 is normal (**b**). Horizontal assessment of nasal projection: from nasal base (Nb), the Pn-Sn to Sn-Nb should be 2:1 (**c**). Nasal base ("worm's eye") view assessment of the nose. The general shape of the alar base should resemble an isosceles triangle (**d**)

and symmetry of the columella are important factors to consider when maxillary surgery (especially superior repositioning or advancement) is contemplated. Fortunately, adverse aesthetic effects as a result of maxillary surgery can be controlled during surgery [4].

Cheeks (Fig. 66.15)

As in the frontal evaluation, the *cheekbone-nasal base-upper lip-lower lip curve* contour line is also very helpful in the profile analysis. The line starts just in front of the ear, extending forward over the cheekbone, downward over the maxilla adjacent the ala of the nose, and ending lateral to the commissure of the mouth. The line should form a smooth continuous curve, and any interruption may indicate an underlying skeletal deformity (Fig. 66.15). The variations in interruptions in the curve and the possible underlying skeletal deformities responsible for the soft tissue deformities are demonstrated in Fig. 66.15b, c [5].

Orbit

The globes of the eye generally project 0–2 mm ahead of the infraorbital rims, while the lateral orbital rims lie 8–12 mm behind the most anterior projection of the globes. The bridge of the nose should be about 7 mm ahead of the globes although there is a significant ethnic difference in this measurement (Fig. 66.14) [6].

Paranasal Area

The flatness or fullness of the paranasal areas is an important indicator to distinguish between middle third deficiency and mandibular anteroposterior excess. Another useful indicator of midface deficiency is the ratio of the linear distance from the nasal tip to subnasale and from subnasale to the alar base crease. The ratio should be 2:1 (Fig. 66.14). A ratio closer to 1:1 will indicate maxillary anteroposterior deficiency, while an increased ratio will indicate decreased nasal projection.

Lips

The lips play an important part in the overall aesthetics of the face and should be carefully assessed before treatment. The effects of treatment as well as the aesthetic changes that may take place during the aging process should be considered. The upper lip usually projects slightly anterior to the lower lip, and the E-line and S-line are helpful guides to assess the projection of the lips (Fig. 66.16) [7].

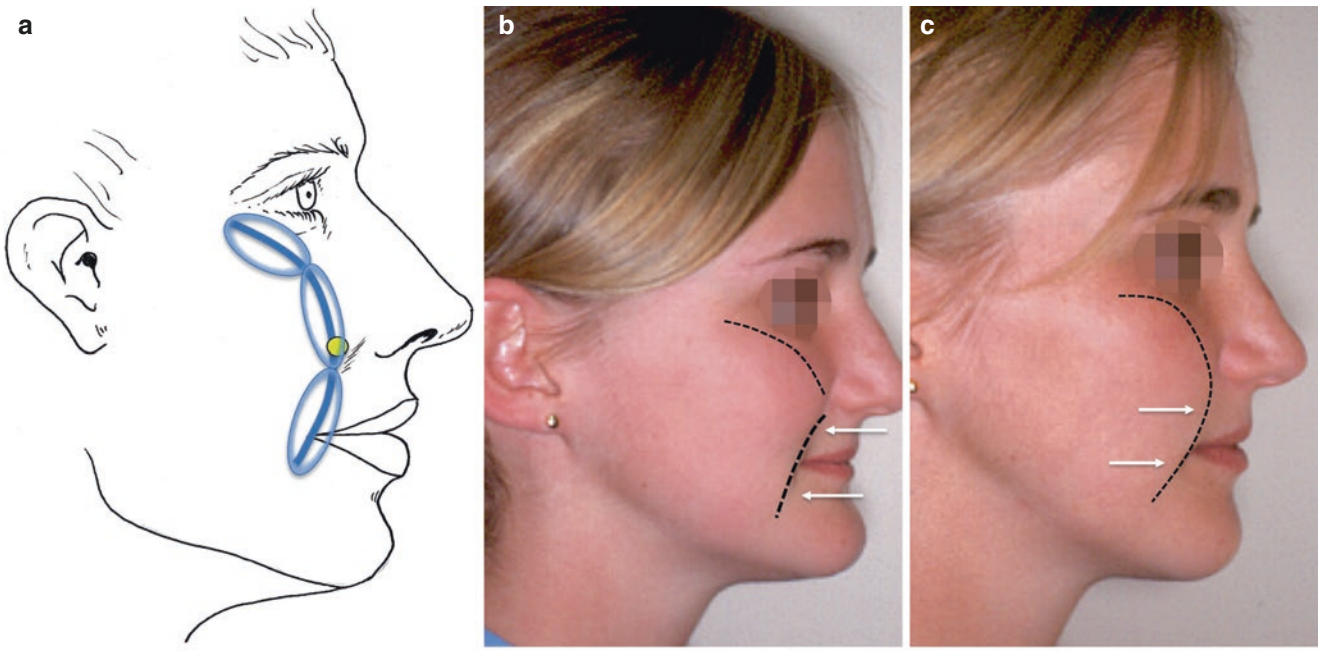

Fig. 66.15 (**a**) The cheekbone-nasal base-lip curve contour. The curve should be unerupted and smooth in an individual with good facial proportions. (**b**) The cheekbone-nasal base-lip curve contour. The interruption of the curve (arrows) indicates maxillary as well as mandibulae anteroposterior deficiency. (**c**) The cheekbone-nasal base-lip curve contour. Following maxillary and mandibular advancement, the curve is uninterrupted and smooth (arrows)

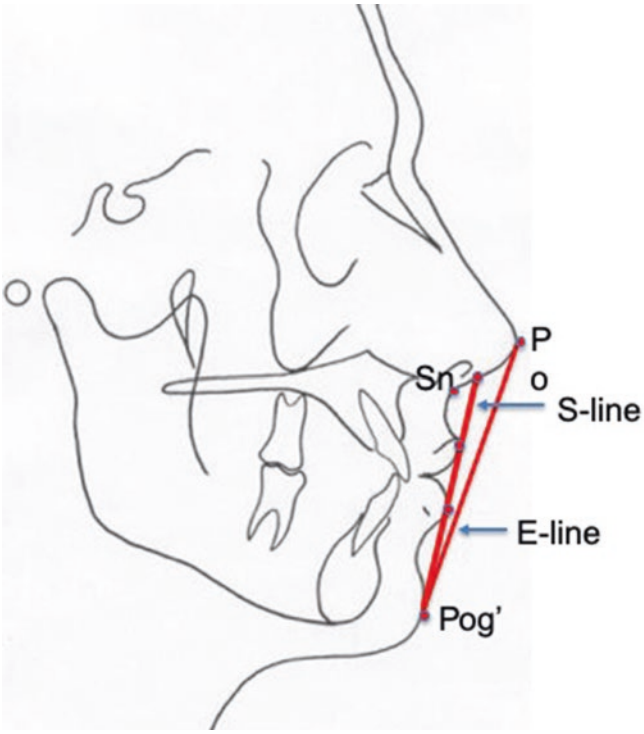

Fig 66.16 Lip prominence. Li should be 2 ± 2mm behind the E-line (Pn-Pog'). Li – Labrae inferioris and Ls – Labrae superioris should just touch the S-line (S-line follows Pog' to the point between Sn and Pn)

Chin

The chin is one of the most noticeable structures in the face and demands special evaluation. The shape of the chin is more important than the position of pogonion. Chin surgery should not be considered for patients requiring mandibular surgery. Performing an advancement genioplasty for a patient as compromise treatment for mandibular advancement may achieve correct chin projection; however, the balance and harmony of the chin will be poor. The authors use seven criteria for the aesthetic profile evaluation of the chin which also serve as a guide to surgical treatment planning (Figs. 66.11, 66.12, and 66.13) [8].

1. Height of the chin. The chin height is measured from lower lip stomion to soft tissue menton and should be equivalent to two thirds of the lower facial height. The linear height should be 40 ± 2 mm for females and 44 ± 2 mm for males. For individuals with deep bites, the measurement should be performed with the teeth apart and the lip separated (i in Fig. 66.12).
2. Vermillion exposure. The lower lip vermillion exposure should be 25% more than the upper lip. The lower lip will be everted with increased vermillion exposure when the lower incisors are proclined or in individuals with an increased overjet (Fig. 66.13).
3. The labiomental fold. The depth of the fold should divide the chin into an upper third and lower two thirds (Fig. 66.11).
4. Chin throat length. Patients with mandibular anteroposterior deficiency will have short chin-throat lengths and vice versa for individuals with mandibular anteroposterior excess. Normal length is considered to be 42 ± 6 mm. This measurement is important when considering setback or advancement of the chin (ii in Fig. 66.12).
5. Lower lip-chin-throat angle. The angle is considered pleasing at 110° ± 8° and tends to be acute in mandibular prognathism and obtuse in mandibular deficiency (Fig. 66.12).
6. S-shaped curvature. The profile of the chin should form a well-proportioned, harmonious and smooth curve (Fig. 66.12).
7. The lower lip position. A helpful guide to the lower lip position is the E-line (aesthetic line). The E-line is drawn from the nasal tip (pronasale) to pogonion. The lower lip should be 2 ± 2 mm behind the line. The measurement will be influenced by the projection of the nose and the anteroposterior position of the chin which should be kept in mind during this evaluation (Fig. 66.13).

Most of the aforementioned aesthetics parameters can also be assessed on a lateral cephalometric radiograph; however, there is no substitute for clinical evaluation of facial harmony. It is hoped that the short overview of the clinical assessment of facial aesthetics will increase the reader's acuity in the treatment of his/her patients. In most instances the orthodontist is the first professional to see patients with malocclusions. Some of these patients may require skeletal and/or soft tissue modification incorporated into the treatment plan, and the responsibility lies with the orthodontist to recognize the dental, skeletal, and soft tissue problems and then to appropriately inform the patient. The aesthetic outcome following orthodontic (and surgical) treatment should be a priority for the contemporary orthodontist.

66.3 Clinical Evaluation

The clinical assessment of the face is probably the most valuable of all diagnostic procedures. While an astute clinical diagnosis can be made at the chair side, photographs are essential for accurate assessment and record purposes. The face is systematically assessed from a frontal view, profile view, and three-quarter view. Figures 66.1, 66.2, 66.3, 66.4, 66.5, 66.6, 66.7, 66.8, 66.9, 66.10, 66.11, 66.12, and 66.13 illustrate some angular and linear parameters used during the clinical assessment of the face.

66.4 Special Investigations

Cephalometric and panoramic radiographs and dental casts are essential; however, temporomandibular joint investigations, Technetium bone scans, hand wrist radiographs, CT scans, etc. may be required. The lateral cephalometric radiograph taken in centric occlusion and the lips in repose allows the clinician to analyze and evaluate the soft tissue, skeletal, and dental relations of a dentofacial deformity.

66.5 Diagnosis and Problem List

A diagnosis is made following the clinical evaluation of the patient, a radiographic evaluation and cephalometric analysis, model analysis, and other indicated evaluations. The data base is used to compile a problem list.

66.6 Treatment Objectives

Clear orthodontic and surgical treatment objectives regarding soft tissue, skeletal, and dental structures should be identified and noted.

Development of a Visual Orthodontic and Surgical Cephalometric Treatment Objective The lateral cephalometric radiograph tracing is used to develop an orthodontic visual treatment objective to predict orthodontic tooth movements. This is followed by the development of a surgical visual treatment objective predicting the required jaw repositioning and expected soft tissue changes [10].

66.7 Treatment Plan

All the factors identified in the diagnosis and problem list as well as patient concerns and reasons for considering orthognathic surgery are considered to formulate a final treatment plan (Flowchart 1). The sequence of treatment and the treatment to be performed by all healthcare professionals concerned are outlined. When defining the treatment plan, a thorough knowledge of the many types of dentofacial deformities and the treatment modalities available to correct them is essential.

The flowchart (Fig. 66.17) summarizes the systematic gathering of data leading to diagnosis and, finally, the development of a treatment plan [9–11].

The basic treatment plan will consist of:

Presurgical Orthodontic Treatment

1. Alignment of both dental arches (with or without tooth extractions)
2. Levelling of both dental arches (in segments or one piece)
3. Deviation of tooth roots at planned interdental osteotomies areas
4. Decompensation of any dental compensations
5. Coordination of dental arches (or segments)

Surgery

The treatment of patients with dentofacial deformities can broadly be divided into four groups. The specific surgical procedure(s) will be indicated by the problem list as discussed:

1. Single jaw surgery—mandibular repositioning (advancement or setback)
2. Single jaw surgery—maxillary repositioning (advancement or setback or superior repositioning or downgraft and/or segmental surgery or a combination)
3. Double jaw surgery
4. Rotation of the maxillomandibular complex

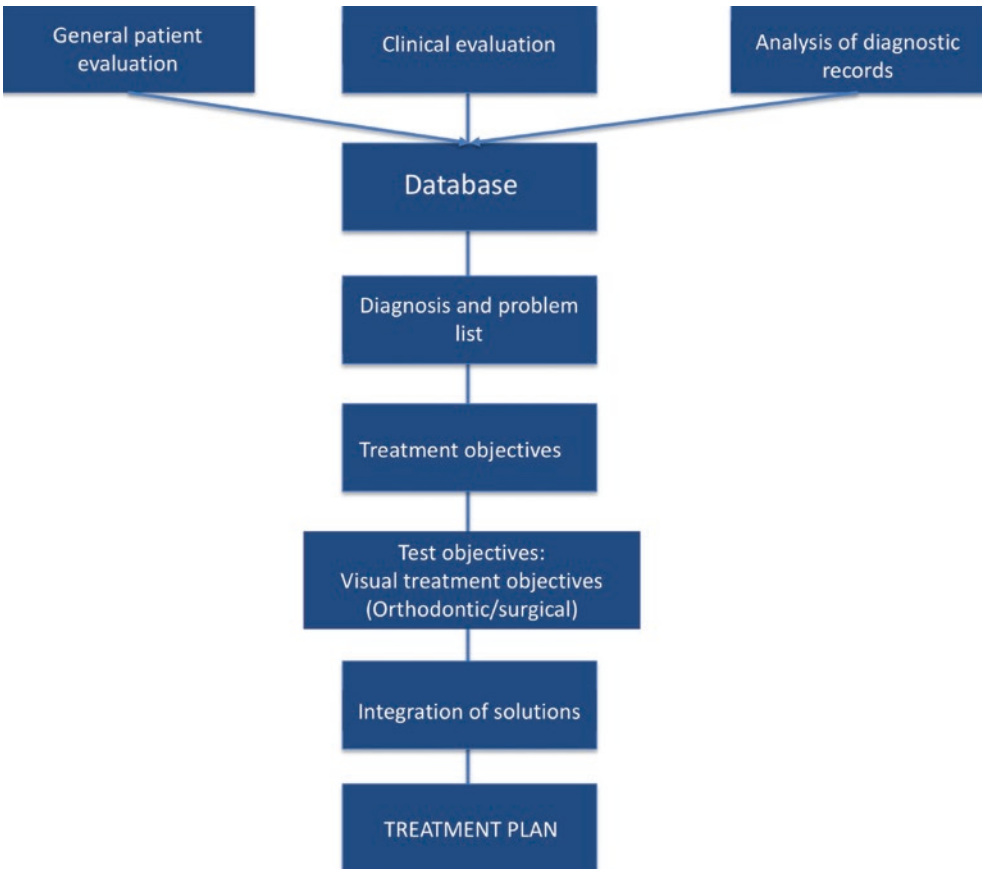

Fig. 66.17 Flowchart 1

For each of the above surgical treatment categories, the orthodontist and the surgeon will have specific responsibilities to make the treatment efforts occur smoothly and successfully. In most surgeries, conventional treatment planning using lateral cephalometric and PA cephalometric radiographs and cast model surgery with surgical splint fabrication is indicated. However the authors use 3D virtual treatment planning for more challenging surgeries such as facial asymmetries, rotation of the maxillomandibular complex, etc. [12, 13].

66.8 Treatment

Although the orthodontist and the oral and maxillofacial surgeon are the main role players, comprehensive correction of dentofacial deformities may involve several members of the healthcare team. The surgeon should understand the orthodontic decision-making process, while the orthodontist must understand the pre- and postsurgical orthodontic requirements. It is mandatory that the therapeutic management is carried out as planned and any problem or change in

treatment plan should be communicated to the treatment team. Successful and knowledgeable practitioners always maintain good interprofessional communication and mutual respect to achieve the best treatment results.

66.9 Conclusion

Successful orthognathic surgery relies on understanding and interpreting a patient's desires, correlating these with the diagnosis, and finally developing a treatment plan and executing it accurately. While virtual 3D planning has provided another tool to aid in diagnosis and surgical planning, it behooves surgeons to continue to develop proficiency in traditional cephalometry-based treatment planning.

66.10 Case Scenarios

Case 1: A female patient suffering from hemifacial microsomia on the left (Figs. 66.18, 66.19, 66.20, 66.21, 66.22, 66.23 and 66.24).
Case 2: A male patient suffering from skeletal Class 3 malocclusion (Figs. 66.25, 66.26 and 66.27)

Fig. 66.18 (**a**) Frontal view; (**b**) note the occlusal cant; (**c**) the mandible swing to the affected side; (**d**) right side profile view; (**e**) left side three-quarter view, note the microtia; and (**f**) the left side profile view, note the microtia

Fig. 66.18 (continued)

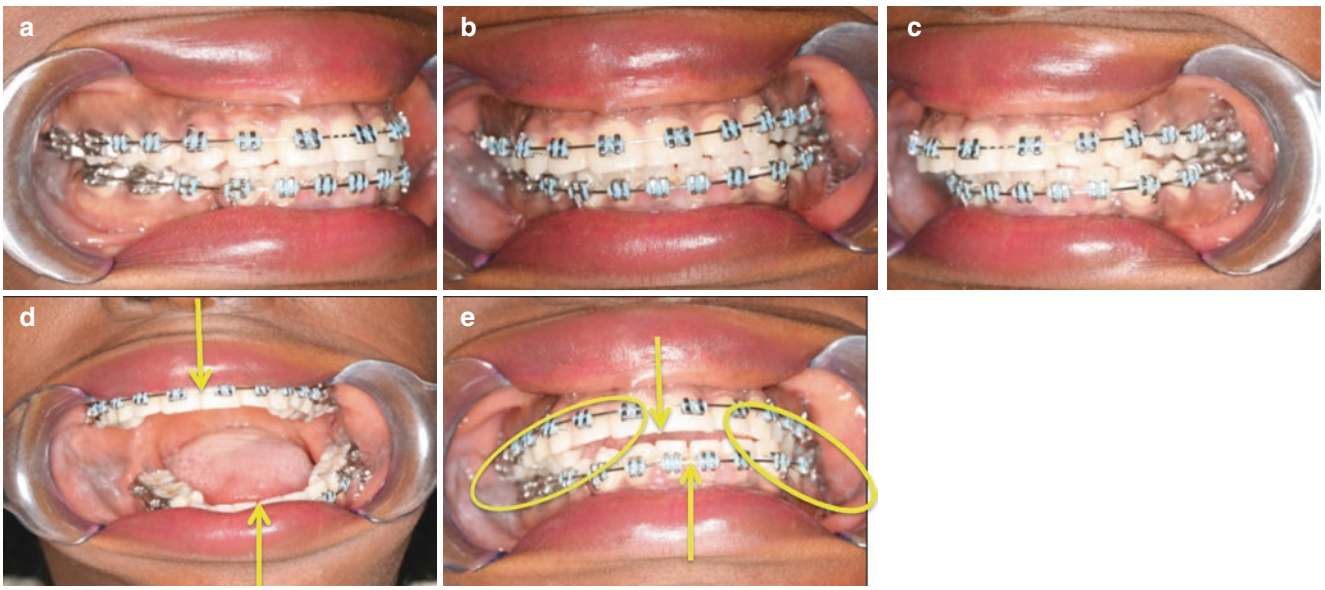

Fig. 66.19 (**a**–**c**) Presurgical occlusion, (**d**) the occlusion swings to the left on mouth opening, and (**e**) the lower dental midline is displaced to the left (arrows) and bilateral cross bites (circles)

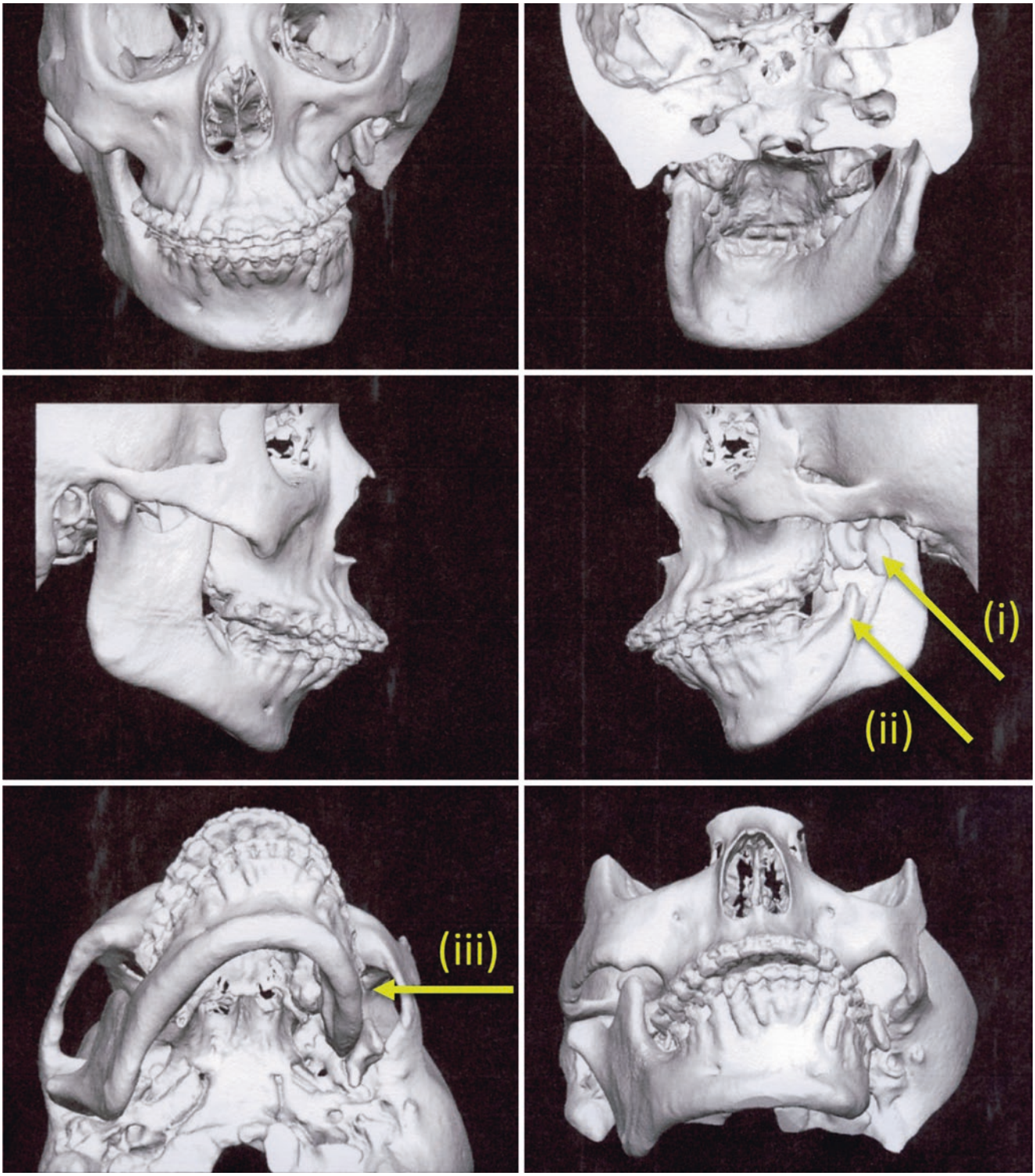

Fig. 66.20 3D images of the skeletal deformities. Note the absence of the left condyle and mandibular ramus (Kaban type III) (i) absence of glenoid fossa, (ii) absence of mandibular condyle, (iii) deficient mandibular ramus on the left side, basal view)

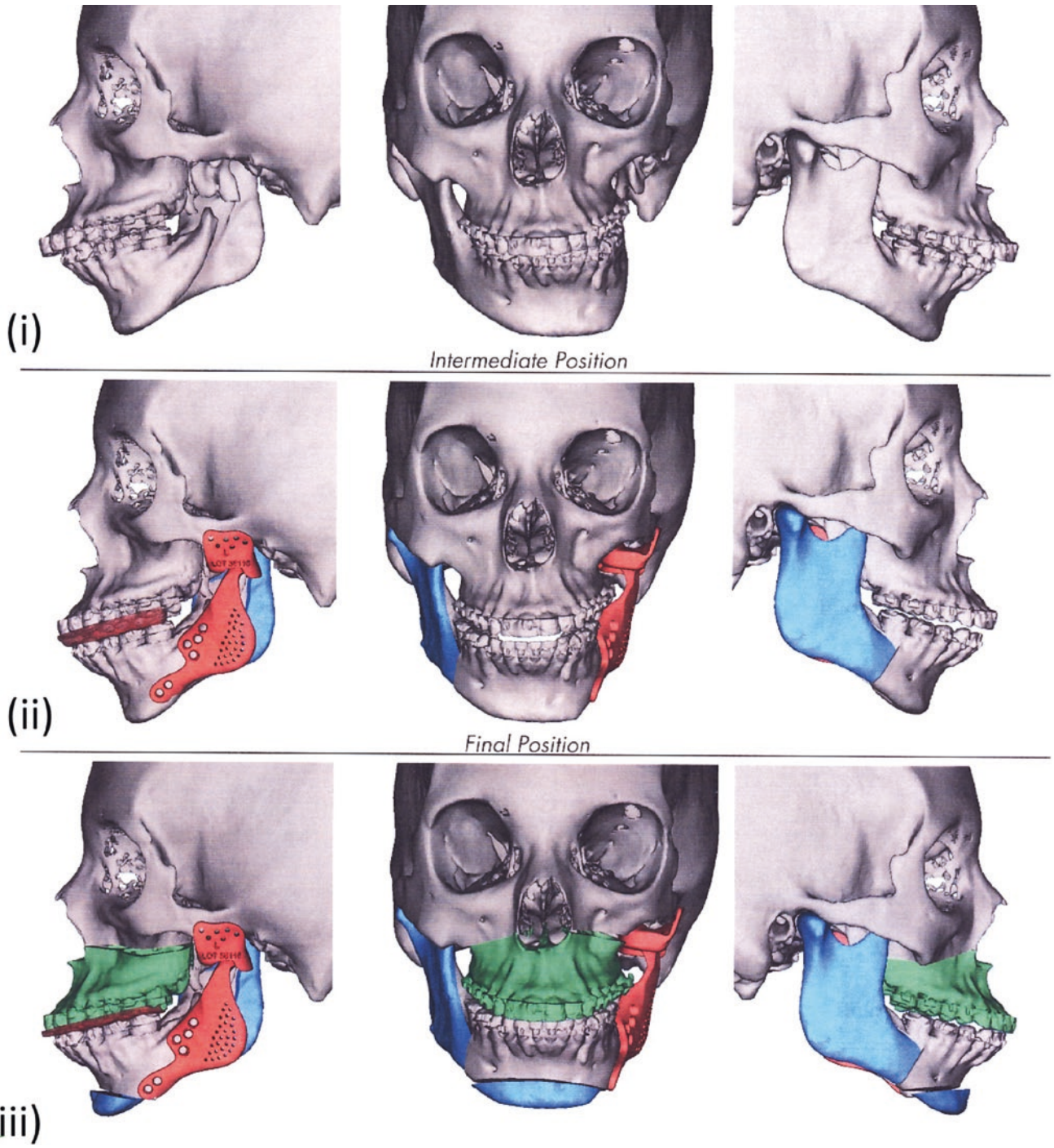

Fig. 66.21 The 3D orthognathic virtual surgical plan: Total joint reconstruction on the left, Le Fort I osteotomy correcting of the maxillary cant, unilateral sagittal split ramus osteotomy on the right, and an advancement genioplasty. (i) Pre-surgical, (ii) intermediate position after mandibular surgery, (iii) Final position after maxillary surgery and genioplasty

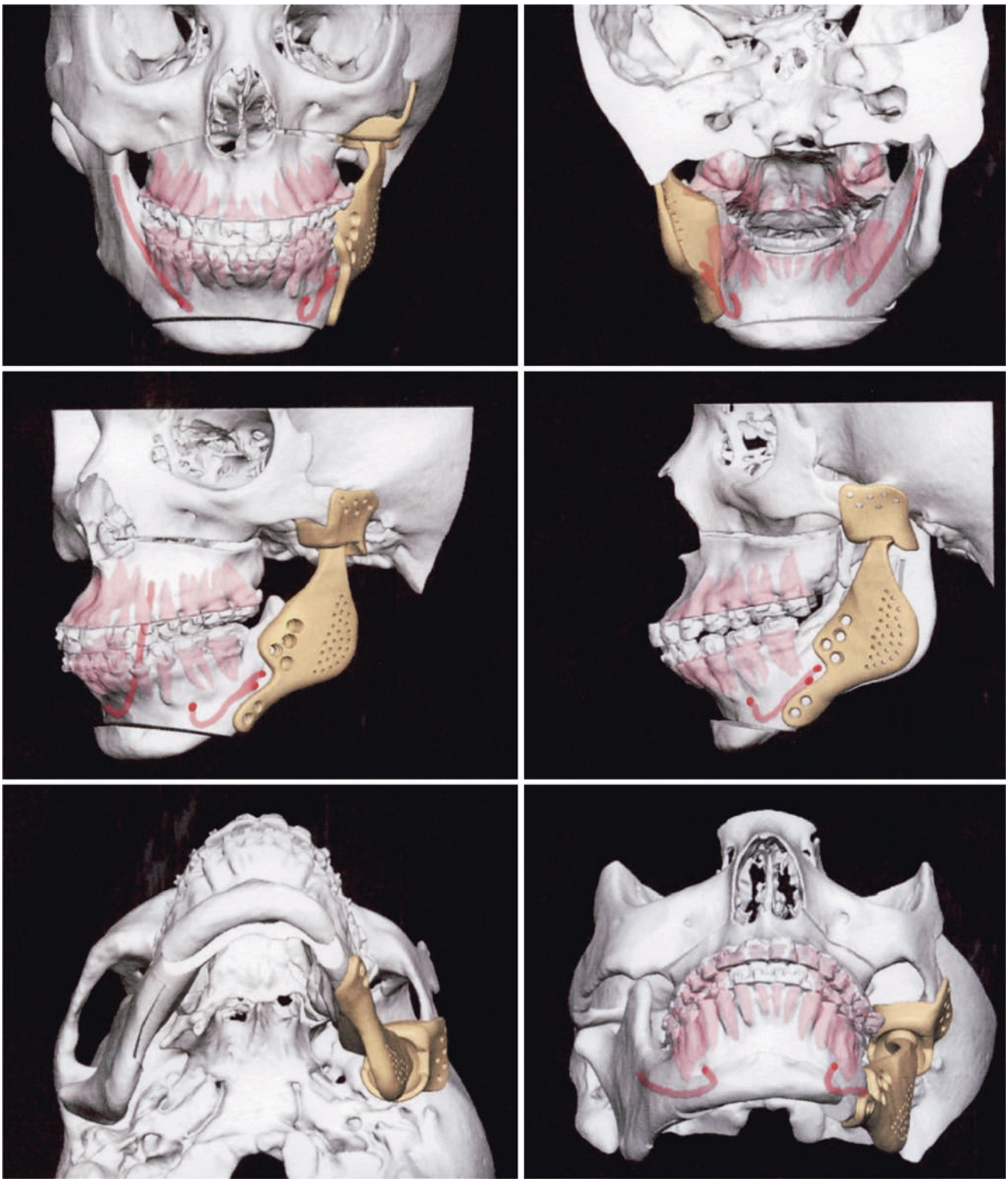

Fig. 66.22 The 3D surgical plan for patient-matched left alloplastic condyle, mandibular ramus and angle

Fig. 66.23 (**a**) Presurgical frontal view, (**b**) postsurgical fontal view. Note the correction of the occlusal cant

Fig. 66.24 (**a**–**e**) Postsurgical frontal and profile views and occlusion

Fig. 66.25 (**a**–**e**) Frontal, profile, and intraoral views of patient with Class III malocclusion. Patient has paranasal flattening, mandible deviated to right, and flat facial profile. Negative overjet, Class III dental occlusion, and mandibular midline to the right

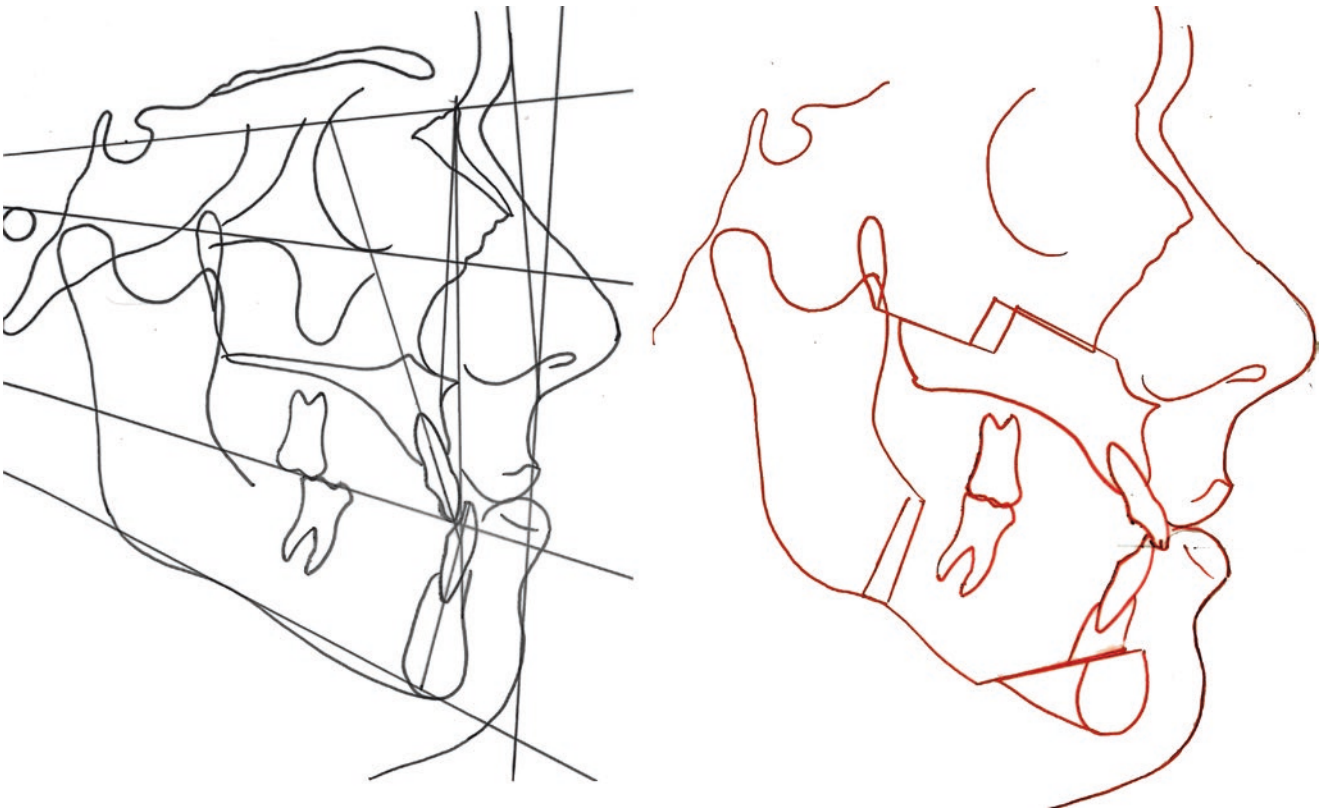

Fig. 66.26 2D cephalometric analysis and 2D surgical treatment planning. Surgical plan is Le Fort I downslide, mandibular setback, and advancement genioplasty

Fig. 66.27 (**a**–**e**) Postsurgical views show that the treatment planning goals have been achieved

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