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Preoperative Facial Analysis



The face is the chief seat of beauty.

Le Camus, Abdeker, or The Art of Preserving Beauty, 1754

Facial plastic surgery is inextricably bound to the concepts of form. The word *plastic* comes from the Greek word meaning to mold or to form. The word *face* comes from the Latin *facia*, an altered form of *facies*, meaning form, figure, or appearance, and hence face or visage. *Surgery* comes from the Latin root *surgia*, meaning the art and practice of treating injuries, deformities, and other disorders by manual operations or instrumental applications. *Facial plastic surgery* can thus be described as surgery on the form of the face. It requires an intimate knowledge of the structure of the normal (aesthetic) face as well as the ability to diagnose the structural differences in patients desiring changes in their facial form.

To adequately evaluate the face, there must be some concept of what is attractive in a given society. The great variation in concepts of facial beauty has long been recognized. In his essays, Montaigne says of beauty:⁴⁵

We fancy its forms according to our appetite and liking: *Belgius turpis romano ore color* (The Belgia complexion of a German lass ill becomes a Roman face—Propertius). Indians paint it black and tawny with great swollen lips, big flat noses, and load the cartilage betwixt the nostrils with great rings of gold to make it hang down to the

mouth... In Peru, the greatest ears were the most beautiful, and they stretched them out as far as they can by art... There are elsewhere nations that take great care to blacken their teeth and hate to see them white; elsewhere, people paint them red ... The Italians fashion beauty gross and massive; the Spaniards, gaunt and slender; among us, one marks it white, another brown; one soft and delicate, another strong and vigorous ... Just as the preference in beauty is given by Plato to the spherical figure, the Epicureans give it to the pyramidal or the square, and cannot swallow a god in the form of a ball.

Even that excellent observer, Charles Darwin, noted the lack of consistent criteria for beauty: "The taste for the beautiful at least as far as female beauty is concerned is not of a special nature in the human mind; for it differs widely in the different races of man, and is not quite the same even in different nations of the same race."¹³

The philosopher Francis Bacon noted the importance of form, the importance of observing the face in motion, and the need to study the entire face, not just individual features:²

In beauty, that of favor [feature], is more than that of color; and that of decent and gracious motion more than that of favor [feature]. That is the best part of beauty, which a picture cannot express . . . There is no excellent beauty, that hath not some strangeness in the proportion. Man cannot tell whether Apelles, or Albert Dürer, were the more trifler; whereof the one would make a personage by geometrical proportions; the other by taking the best parts out of diverse faces to make one excellent. Such personages, I think, would please nobody but the painter that made them. Not that I think a painter may make a better face and never was; but he must do it by kind of felicity (as a musician that maketh an excellent pair in music), and not by rule. A man shall see faces, that if you examine them part by part, you shall find never good; and yet altogether do well.

Beauty may be hard to define, but "we know it when we see it." It requires, at a minimum, a facial form which is pleasing to the eye and appropriate for age, sex, race, and culture. Ultimately, the success of any facial plastic procedure will depend upon the aesthetic sense of the surgeon. To a large degree this aesthetic sense cannot be taught, although certain measurements and guidelines are helpful. This chapter will stress an evaluation of the anatomic deficiency as the key to preoperative planning. Whenever possible, structural changes should be made with like material and as anatomically as possible for excellent and long-lasting results.

As in any other clinical discipline, evaluation begins with a thorough history and physical examination. These most important steps are then followed by further studies as photographic analysis and cephalometric evaluation.

It is especially important to evaluate the patient's motivation and goals as well as to document the more routine medical history. The effects of drug use, allergies, cigarette smoking, and so forth on the outcome of surgery are well-known and appreciated. Special emphasis should be given to ensuring that the patient does not take any aspirin-containing product for at least 2 weeks prior to surgery. A list of such compounds can be given the patient to help them. This list should be updated frequently.

The importance of physical examination was emphasized by Gillies:²³

The majority of failures in plastic surgery are due to errors, the commission of which would lead to failure in any form of surgery. Thus mistakes in diagnosis due to inadequate examination are perhaps the most common cause of indifferent treatment. This element of difficulty in diagnosis may not at first sight be obvious. The word diagnosis in this work is used in its literal sense, namely, to mean a thorough knowledge of the condition present—i.e., the exact loss in terms of anatomical structure.

Careful observation of the facial proportions, contours, and skin quality is made. This observation is followed by a palpation of the structures, including skin, subcutaneous fat, and the underlying bony and cartilaginous framework of the face. Palpation is especially important in the nasal area to assess tip support, the relative contribution of skin and hard tissue to form, and the length of the nasal bones.

The anatomic structure of the face can be conceptualized as a tripartite composite of (1) skin; (2) adipose tissue and muscle; and (3) hard tissue foundation (bone, teeth, and cartilage). The skin and underlying soft tissue create the soft-tissue envelope. Skin varies in thickness, color, and elasticity. Together these skin characteristics combine with local anatomy to create facial aesthetic units or subunits. The quality of fat and muscle as well as their distribution contribute to the facial contour and help determine what corrections are possible. The basic form of the face is determined by the underlying hard tissues. Of particular importance to facial contour are the nasal bones, the supraorbital rims, the malar eminences, the mandible, and the hyoid bone. Aesthetic surgery is more and more concerned with procedures on this bony framework. The relationship between changes made in the hard tissues and the ultimate soft-tissue position is complex, however. In areas with thin elastic skin (such as the nasal dorsum) a bony change may result in the same soft-tissue change (1:1); on the other hand, a change in the bony chin may result in less of a soft-tissue change (e.g., 0.9) in the thick overlying soft-tissue profile.¹⁹

REGIONAL VARIATIONS IN SKIN

In the face, there are definite regions where the skin varies in color, texture, thickness, and mobility. These areas were well-described by Gonzales-Ulloa in his paper on total restoration of the facial skin.²⁵ He described the basic facial areas (Figs. 27-1 and 27-2) and made some detailed measurements of the average thickness of the skin in microns. He found the following thicknesses in microns (including epidermis, dermis, and hypodermis): mental region, 2544; forehead, 2381; upper lip, 2148; lower lip, 1915; lobule of nose, 1764; neck, 1697; cheek, 1509; root of nose, 691; and lids, 593. This principle of facial units has been refined in recent years with the subunit principle. Burget and Menick in a series of papers have defined the subunits of the nose and lip.^{8,9,41} These subunits are topographic units with a predictable contour from person to person. By placing incisions at the boundaries of these subunits, the final scars are visually minimized, since the eye is expecting a contour change. Their work, based on the teachings of Millard, refines that of Gonzales-Ulloa and is applicable to cosmetic as well as reconstructive surgery. Our concept of the basic facial units and subunits is demonstrated in Figure 27-2. Although the forehead and cheek



FIGURE 27-1. Regional variations in the skin as described by Gonzales-Ulloa. (Gonzales-Ulloa M. Total reconstruction of facial skin. Plast Reconstr Surg 1961; 29:155.)

are one unit in terms of contour, they have areas of variation in skin thickness which are illustrated in the figure as dotted lines.

AGE



The effects of age on facial form are important. As the face ages, it undergoes characteristic biomechanical,

FIGURE 27-2. Major facial units and subunits. (Gonzales-Ulloa M. Total reconstruction of facial skin. Plast Reconstr Surg 1961; 29:155.)

biochemical, and histologic changes, in addition to the more obvious gross anatomic changes. Familiarity with these changes will help the surgeon analyze more clearly the results and limitations of aesthetic procedures on the aging face.

According to clinical, cadaver, and radiographic studies, defined anatomic changes occur in specific areas of the aging face.^{24,25,26} The skull becomes thinner and smaller with age, causing an excess of overlying facial tissue. Beginning at age 25, the eyebrows steadily descend from a position well above the superior orbital rim to a point far below it; sagging of the lateral aspect of the eyebrows makes the eyes seem smaller. The excess of skin above the eyes (dermatochalasis), combined with a weakening of the orbital septum, allows intraorbital fat to herniate and creates palpebral bags (Fig. 27-3.²⁶

Progressive descent of the nasal tip with age causes the upper and lower lateral cartilages to separate, thus enlarging and lengthening the nose.³⁴ Progressive resorption of alveolar bone results in a relative excess of soft tissue in the perioral area. The chin descends in much the same way as do the nasal tip and the brows. The well-defined angle between the submandibular line and the neck is lost. Also, the hyoid bone and the larynx gradually descend, making the larynx look more prominent.

The sequence of changes that occur in the aging face is relatively uniform; however, the rate of change varies from person to person (Fig. 27-4). At about age 30, sagging of the facial skin first becomes apparent and is 486 AESTHETIC FACIAL SURGERY





FIGURE 27-3. Cross section demonstrating the weakening of the orbicular muscle and orbital septum in the aging eye.



Age 30

















most obvious where the upper eyelids overlap the palpebral lines. Also, the nasolabial folds deepen. At approximately 40 years of age, forehead wrinkles and horizontal skin lines at the lateral canthus begin to appear, and undulation of the mandibular line becomes noticeable. At age 50, the lateral canthus begins to slant downward, the nasal tip starts to descend, and wrinkles appear in the perioral area and neck. About the same time, some absorption of adipose tissue in the temporal and cheek areas occurs. At 60 years of age, the illusion of decreased eye size becomes pronounced, the skin is thinner, and fat absorption in the buccal and temporal areas is more marked. By 70 years of age and thereafter, all these changes combine with progressive absorption of subcutaneous fat.

Most changes in the external appearance of the face are the result of gravity acting on skin that is becoming progressively thinner, drier, and less elastic.²¹ The skin itself shows increased wrinkling and pigmentary changes with age. Overexposure to sunlight hastens the skin changes and speeds up the aging process. Genetic factors influence the localization and shape of facial wrinkles and the age at which hair turns gray and alopecia develops.

Electron-microscopic examination of the undersurface of aged skin shows a general loss of epidermal complexity (Fig. 27-5).^{36,44} The epidermis of wrinkles is flattened and has few microvilli, whereas the basal cells surrounding wrinkles contain the normal dense microvilli. The delicate elastic fiber network characteristic of young skin becomes dense and less organized with the passage of time.¹⁰ Collagen synthesis and degradation decrease with age; in addition, the collagen in aged skin is probably more stable (due to an increased number of nonreversible crosslinks) than that in young skin.

Many of the gross and microscopic changes seen in aged skin also occur in younger skin exposed excessively to sunlight.^{18,21,37} Using the electron microscope to study aging human skin, Montagna and Carlisle found that the changes in areas protected from sunlight were similar to but less severe than those in areas exposed to sunlight.⁴⁴ In particular, they noted a loss of topography of the undersurface of the skin and degeneration of the architecture of fine elastic fibers and blood vessels in aging skin. Gonzales-Ulloa and Flores, in a study of cadavers, found that skin from various sites on the face was thinner in aged persons that in young adults.²⁴

Keratinocytes from sun-exposed skin grown in culture have a shorter life span than those from skin protected from sunlight.²¹ The tendency to colony formation is increased in sun-exposed keratinocytes, possibly reflecting early malignant transformation. Fewer epidermal Langerhans' cells are present in sun-exposed skin specimens than in sun-protected specimens.

As water-binding capacity and sebaceous gland activity decrease with age, the skin becomes drier. De-



FIGURE 27-5. Scanning electronmicroscopic view of the undersurface of the aging skin demonstrating loss of complexity beneath rhytids.



FIGURE 27-6. Stress-strain curves of young and aged skin demonstrating loss of elasticity.

creased sebaceous gland activity is primarily related to androgen production; sebum production falls steadily in women after menopause but remains fairly stable in men until about age $70.^{50}$

Biomechanical correlates of these histologic changes can be measured both in vivo and in vitro by stretching a piece of skin and measuring the force required to move it a given distance. Figure 27-6 shows typical in vitro stress-strain curves for aged and young skin. The initial stretch that occurs with application of relatively little force (area I of stress-strain curve) corresponds primarily to the deformation of elastic fibers. Area II corresponds to a gradual straightening of the randomly arranged collagen fibers in the dermis. In area III, almost no deformation is possible because all the collagen fibers are arranged parallel to the force and thus the skin is extremely stiff. The difference in the stress-strain curves of young and old skin probably results from age-related destruction of the elastic fiber network and changes in the ground substance of the dermis. The mechanical properties of human skin in vitro and the age-associated changes have been studied by a number of investigators.¹²

An evaluation of this age-related skin elasticity is important in the preoperative evaluation of many procedures, for example, deciding whether a liposuction in an older patient will give a good result.

RACE

Race is clearly an important variable in facial analysis. Although one can make general comments about racial types, the individual patient evaluation is more important. The conclusion to the chapter on ethnic considerations in *Cosmetic Plastic Surgery in Nonwhite Patients,* by Harold E. Pierce, is worth quoting:⁴⁹

While there are significant anatomic differences in the racial physiognomy of whites and nonwhites, in facial cosmetic surgery there are but a few required modifications in technique. The major difference concerns rhinoplasty. Keloids and pigmentary alterations, while a consideration in an elective procedure, do not generally preclude such procedures in carefully selected patients.

A schematic drawing of typical differences in black, Asian, and white facial features is seen in Figure 27-7. Cephalometric differences between the races are discussed later in this chapter. In addition to general facial form, there are racial differences in the skin itself. Both blacks and Asians tend to have thicker skin and a greater tendency to form hypertrophic scars or keloids. They are also more likely to develop pigment changes after dermabrasion and chemical peels. There are racial differences in specific anatomic areas. For example, the Asian eyelid lacks the insertions of the levator aponeurosis fibers into the dermis and, therefore, does not have a high, well-defined lid fold. The most well-studied of these racial differences are those in nasal anatomy. Hinderer, basing his work on the work of Cottle, described three nasal types with typical racial characteristics.³⁰ He used the nasal index (a ratio of the nasal width between piriform crests and the length of the nose) and the tip index (the ratio of the width of the nose at the nostril apex to the width at the widest expansion of the ala) to measure these differences; these indices had been used previously in anthropological literature.⁵⁸ He divided the nose types into the leptorrhine (caucasoid), mesorrhine (oriental), and platyrrhine (negroid) (Fig. 27-8). These observable differences are based on specific anatomic differences; for instance, in the platyrrhine nose there is a thicker skin, a deficiency of the nasal spine, and a relative deficiency of cartilage and support in the nasal tip.

The mandibular-maxillary and dental relationships are different among the races and have been documented cross-culturally with cephalometric studies (usually with Steiner analysis). The following cephalometric studies in nonwhite populations compared their measurements to "the Alabama analysis," an evaluation of Southern white children done by Taylor and Hitchcock, in which 17 boys and 23 girls underwent cephalometric study with careful statistical analysis.⁶⁴ There were no significant sex differences. Of 32 measurements made, 16 were selected as statistically significant and clinically useful.

Guo studied 96 Chinese children and found striking differences between Chinese and white dentofacial pat-

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FIGURE 27-7. Typical racial differences in facial features. (Pierce HE. Cosmetic plastic surgery in non-white patients. Philadelphia: WB Saunders, 1982:44.)

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NASAL

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FIGURE 27-8. Nasal types with racial characteristics as described by Hinderer. (Hinderer KH. Fundamentals of anatomy and surgery of the nose. Aesculapius Publishing, 1971:154.)

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terns.²⁸ In Chinese children, the mandible and the chin had a tendency towards a retrognathic position, and there was also a more marked bimaxillary protrusion of the anterior teeth. His study showed minor variations between Japanese and Chinese children. Miura and coworkers evaluated 90 Japanese children.⁴³ They found that the primary differences between the American whites and the Japanese studied were the presence in the Japanese of more labially inclined upper and lower incisors and the retroposition of the mandible in the Japanese. There were no sexual differences in either the Chinese or Japanese studies.

Drummond performed cephalometric examinations on 40 American black children and compared the results to the Alabama study of white children.¹⁶ Alexander and Hitchcock performed a similar study on 50 black children in the same area of Alabama in which the previous study of white children was performed.¹ Both of these studies found two primary differences between the white and black children: (1) In blacks, the maxilla is proportionally more anteriorly placed; and (2) the upper and lower incisors are more procumbent and protrusive in blacks.

Garcia performed a similar study in 59 Mexican-American children in Los Angeles.²⁰ Again, there were no significant differences between the cephalometric values of boys and girls. Skeletally, the Mexican Americans' mandibles were more protrusive than the whites; there were also minor differences in the position of the incisors.

SEX

There are clearly anatomic differences as well as different standards of beauty between men and women in specific facial areas. The most obvious is in hair distribution, which becomes important in designing flaps such as forehead-lift and face-lift flaps. For these cases, an evaluation of the hair density, shape of hairline, and, in men, beard density and distribution is necessary. The female brow tends to be more arched than the male. The highest point is normally between the lateral limbus and the lateral canthus. The male brow is usually more horizontal. In the neck area, the thyroid cartilage in men is more prominent than in women. It is in profile analysis that the differences between men and women become most obvious. In an interesting study comparing preferred profiles of men and women, Lines and coworkers demonstrated significant differences by sex in the most aesthetically pleasing profiles.³⁹ As shown in Figure 27-9, the man has a more prominent nose and chin, and a more acute nasolabial angle.



FIGURE 27-9. Variation in male and female aesthetic profiles. (Lines PA, et al. Profilemetrics and facial aesthetics. Am J Orthod 1978; 73:648.)

REGIONAL ANATOMIC ANALYSIS

Specific areas of the face require specialized analysis. The most obvious of these are the nose and eyelid areas. These will be discussed only superficially here, as they are discussed in depth in other chapters. There are, however, other areas of the face that are occasionally neglected and yet deserve attention. One such region is the teeth. A simple evaluation of the patient's occlusion should be performed as part of the physical examination. If there are variations from normal, they should be described using Angle's classification (Fig. 27-10):

- *Class I (orthognathic):* The mesiobuccal cusp of the maxillary first molar rests in the mesiobuccal groove of the mandibular first molar, and the maxillary canine occludes with the distal half of the mandibular canine and the mesial half of the mandibular first bicuspid.
- *Class II (retrognathic):* The buccal groove of the mandibular first molar is distal to the mesiobuccal cusp of the maxillary first molar, and the distal surface of the mandibular canine is distal to the mesial surface of the maxillary canine.



FIGURE 27-10. Angle's classification of occlusion. (A) class I (orthognathic); (B) class II (retrognathic); and (C) class III (prognathic).

Class III (prognathic): The buccal groove of the mandibular first molar is medial to the mesiobuccal cusp of the maxillary first molar, and the distal surface of the mandibular canine is mesial to the mesial surface of the maxillary canine.

In addition to the Angle classification, one should describe any crossbite, openbite, overjet (maxillary incisors labial to the mandibular incisors), or overbite. Finally, one should observe the amount of incisor showing beneath the upper lip both at rest and smiling (normal is 2 mm at rest and no more than 3 mm when smiling).⁵¹

Analysis of the neck is of particular importance. The surgeon should evaluate the anatomy of the platysma muscle, the relative positions of the hyoid bone and the mentum, the fat distribution, and the skin laxity (Fig. 27-11). Dedo has designed a classification for cervical abnormalities.¹⁴ The first class of patient has a well defined cervicomental angle with good platysma tone and absence of fat. The second class shows sagging cervical skin without excess fat or platysma banding. The third class has adipose tissue in the cervical area of either congenital or acquired origin. The fourth class of patient

has banding of the platysma muscle. The fifth class of patient has either congenital microgenia or a relative retrognathia from atrophy of the soft tissues and bone absorption. The sixth class of cervical deformity is characterized by a low-lying hyoid bone. These classes are not mutually exclusive, but it is important to analyze the separate components noted above, so they can be corrected individually. As mentioned earlier, the quality of the hair and hairline position are of importance in a variety of aesthetic procedures, and should be carefully examined at the initial consultation.

A final area, which should be evaluated purposefully (and is frequently overlooked), is the malar complex. A prominent malar area is an element of both beauty and youth. This is also a region (much like chin position) where the surgeon must make a conscious effort at preoperative evaluation, or an opportunity for significant improvement may be lost. The malar eminence has a complex contour and is not well analyzed with twodimensional lines. The soft-tissue contour is formed by the underlying bony contour and the soft tissues, including the attachment of the masseter muscles and buccal



FIGURE 27-11. Cervical abnormalities associated with changes in the aging face.

fat pad. The commonly used Hinderer analysis draws one line from the lateral commissure of the lip of the lateral canthus.³¹ Another line is drawn from the inferior aspect of the ala to the tragus area. The area posterior and superior to the junction of these two lines should be the most prominent part of the malar eminence (Fig. 27-12). Powell and associates have re-evaluated the position of the malar eminence and developed a different system.⁵² A vertical line is drawn from the nasion to the nasal tip and bisected with a horizontal line which extends, curving laterally, to the tragus of the ear; this line will locate the vertical position of the malar prominence. Two additional reference lines are drawn; the first is from the ala of the nose to the lateral canthus, and the second from the lateral commissure of the lip parallel to the first line. The point where the most lateral oblique line and the horizontal line cross should represent the most aesthetic area for the prominence of the malar eminence (Fig. 27-13). Although this type of subtle curve does not lend itself well to simple analysis, these guidelines are helpful in setting the most prominent point.

An aesthetically pleasing nose has certain characteristics which are depicted in Figure 27-14. The proportions between the alae and the lobule should be approximately 1:1 in the lateral view. From the basal view, the columella should be approximately twice the length of the lobule. The nasolabial angle usually measures 90° to 115° with a double break. The long axis of



FIGURE 27-12. Hinderer analysis of the malar eminence.



FIGURE 27-13. Powell's analysis of the malar complex.⁵²

the columella should be parallel to the long axis of the nostril rim. However, in many cases there is a deformity of the columella (*e.g.*, hanging columella) and the long axes of these structures are not parallel. For this reason, the nasolabial angle is not a good measure of nasal tip rotation. A more precise parameter is the inclination of the long axis of the nostril rim relative to the Frankfort

horizontal. The Frankfort horizontal connects the orbitale (lowest point of the infraorbital rim) and the porion (highest point of the external ear canal). The inclination of the long axis of the nostril rim to the Frankfort plane should range from 15° to 30° in women, and 0° to 15° in men, depending on the height of the patient. There is usually a subtle superlobular dip in the dorsal profile, and 2 to 4 mm of columella shows from the lateral view. From the frontal view, there should be a gentle curve from the supraorbital rim to the tip area as described by Sheen (Fig. 27-14).⁵⁹ It is difficult to define tip projection in a simple manner; the perceived size of the nose depends on its relationship to multiple other facial characteristics as well as the patient's height and weight. Two simple techniques for measurement of tip projection, however, are seen in Figure 27-15. As described by Simons, the ratio of the distance from the upper lip to the subnasale should be approximately the same as the distance from the subnasale to the tip.61 Although clinically useful, this method is limited by the high variability in the length of the upper lip. The method of Crumley describes a right angle triangle with vertices at the nasion, nasal tip, and alar crease, whose sides have 3:4:5 proportions.¹¹ This 3:4:5 triangle actually relates very well to another measurement of tip projection: the nasofacial angle as described by Brown and McDowell.⁷ This is the angle between a line touching the forehead and chin and one on the dorsal plane of the nose. They believed an ideal nasofacial angle to be about 36°, with desirable limits between 30° and 40°.

Finally, one needs to study the face dynamically. Each division of the facial nerve should be examined for function and symmetry. Many patients have significant morphological changes with smiling (*e.g.*, depression of the nasal tip because of the depressor nasi septi and zygomaticus muscles, or a downward and anterior



FIGURE 27-14. Typical measurements of the aesthetically pleasing nose.

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FIGURE 27-15. Measurements of tip projection using the methods of Simons and Crumley.

movement of the malar prominence from its muscular attachments).

FACIAL PROPORTIONS

Our current concepts of an aesthetic profile probably began with the Egyptians. Profiles such as that of Queen Nefertiti (1365 B.C.) have influenced artists up to modern times. Egyptian concepts of beauty included a relatively broad face, sloped forehead, prominent eyes, full lips, and a relatively prominent chin. It was the Greeks, however, who set many of our standards for facial proportions. Statues such as those of Apollo Belvedere and Aphrodite have influenced our concepts of male and female beauty. In 1900, Angle in his book on malocclusion described the sculpture of Apollo: "Every feature is in balance with every other feature, and all the lines are wholly incompatible with mutilation or malocclusion."⁴⁸ Typical Greek faces were oval and included a slight taper to the chin, a prominent anterior forehead, and a nose beginning almost at the glabella with a very flat nasal frontal angle. The Romans changed our view of facial aesthetics very little, but were immensely helpful in preserving the work of the Greeks. During the Middle Ages, when emphasis was placed on mind and spirit as opposed to the body, few new attitudes appeared concerning facial proportions.

The period of modern facial analysis began in the Renaissance with the work of Leonardo da Vinci. As an artist and scientist he was uniquely qualified to develop a science of facial proportions. This artist began his Notebooks: "Let no man who is not a mathematician read the elements of my work."55 Leonardo was influenced by the Roman architect Marcus Vitruvius Pollio (31 B.c. to A.D. 14) who described the division of the face into three parts (De Architectura Libri Decem, Book III, Chapter I). He describes these basic proportions as follows: "From the tip of the chin to the nose, from the tip of the nose to the midpoint of the eyebrows, and then to the root of the hair, each one-third."63 Leonardo's drawings showing these proportions are seen in Figure 27-16. The German artist Albrecht Dürer was twenty years younger than Leonardo, but he spent the year 1506 in Italy and was probably influenced by him. In his book The Human Figure, there are many meticulous facial analyses such as those seen in Figure 27-17.63 Both Leonardo and Dürer



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FIGURE 27-17. Facial anlaysis of Dürer.

were more interested in the realistic depiction of faces than in defining an aesthetic ideal.

The last century has seen objective measurements of facial proportions in specific populations. The majority of this work has been done by orthodontists in their development of both hard tissue and soft-tissue cephalometric measurements; a notable exception is the extensive anthropometric work of Farkas.¹⁷

It is important to measure overall facial proportions.⁴⁷ In the vertical direction, the facial thirds of Leonardo are very helpful and can be measured directly from patients or photographs. As seen in Figure 27-18, the width of the nose at its base should be approximately equal to the distance between the eyes. The length of the upper lip is about twice that of the lower lip and chin.

In analyzing the front view, one should also consider the overall shape of the face. A 3:4 ratio between the width and height of the head is fairly typical, but there is wide variation. Faces can be classified as square, round, oval, or triangular. A square or round face may suggest a somewhat wider and shorter nose than an oval or triangular one. An oval face is considered most pleasing.⁵

From the lateral view, the general shape of the facial profile is important in aesthetic surgery. The basic concept of facial convexity was well-described by Woolnoth in 1865: "The general form and outline of all faces, especially as they are seen in profile, are of three orders—the straight, the convex, and the concave. The straight face is considered the handsomest."⁴⁸ Gonzales-





FIGURE 27-18. Generalized facial proportions from a frontal view.

Ulloa defined a straight face with his profileplasty; in his technique a line is dropped from the nasion perpendicular to the Frankfort horizontal and should touch the forehead, lips and chin.²⁷ The anterior-posterior relationship between the chin and the remainder of the profile is of practical significance. No simple measurement can define chin position exactly. Studies of aesthetic references and classical art have shown a preference for a relationship in which the lower lip is slightly posterior to the upper lip and the chin lies on a straight line connecting the two (the male chin may be somewhat more anterior). The technique of Rish is widely used.⁶⁰ With his system, a perpendicular line is dropped from the mucocutaneous junction of lower lip and chin, and augmentation is considered if the chin does not reach this line. Obviously, the patient's occlusion and the functional mandibular-maxillary relationship should be considered prior to simple cosmetic chin augmentation.

The relatively simple study of facial proportions presented thus far is adequate for the vast majority of cases. When a more detailed analysis of the facial profile is required, the surgeon can proceed to hard-tissue cephalometrics, soft-tissue cephalometrics, or more complex three-dimensional methods. Excellent reviews of the various cephalometric systems are available.*

* References 32, 33, 38-40, 42, 46, 48, 51, 53, 56, 62, 65, 66, and 67.

Cephalometric Analysis

As aesthetic surgery involves more extensive work on the bony framework of the face, cephalometric analysis becomes more important. Multiple systems have been described; the majority have been developed by orthodontists to evaluate the relationship of the teeth to the surrounding bony and soft-tissue coverings. These systems can be quite useful, particularly in evaluating vertical facial proportions and relationship of the maxilla and mandible to the cranial base. In this chapter, we will present some of the basic terminology and a few of the more basic relationships to assist the readers in orientation. The systems selected by a surgeon will depend on the specific cases involved and the desires and training of the individuals. Measurements can be made from a lateral cephalometric film, from direct soft-tissue facial measurements, from photographs, and from CT scans. Computers can be useful in analyzing the data.^{29,35}

Hard-Tissue Cephalometric Analysis

For hard-tissue cephalometrics, the American standard cephalometric arrangement is used (Fig. 27-19).⁵³ The distance from the x-ray source to the patient's midsagittal plane is split; the distance from the midsagittal plane to film can vary by medium but must be consistent for each patient. There are various headholders, but basic stabilization is achieved with a pair of ear rods in the



FIGURE 27-19. The American standard cephalometric arrangement. (Reproduced by permission from Proffitt WR. Contemporary orthodontics. St. Louis: CV Mosby, 1986:142.)

external auditory meatus and with one resting on the intraorbital rim or nasion. These rods also mark one of the major points, the upper margin of the external auditory canal. The line that connects this point to the orbitale is termed the *Frankfort horizontal*. The Frankfort horizontal was defined at the International Congress of Anthropology held in Frankfort in 1884 and was based on a horizontal line introduced by Von Ihering in 1872.⁴⁶ (A true horizontal can be used for cephalometrics, photography, and other analysis. This natural head position is quite reproducible and is achieved by having the sitting patients look into their own eyes in a mirror).³

Some common cephalometric points used in hardtissue analysis are seen in Figure 27-20 and include the following: the orbitale (O), or most inferior point on the infraorbital rim; the nasion (N), the anterior point at the nasofrontal suture; the center of the sella turcica (S); the tip of the anterior nasal spine (ANS); the most retruded portion on the premaxilla between the nasal spine and incisor (A point); the deepest point of the



FIGURE 27-20. Standard hard-tissue cephalometric points. *N*, nasion; *O*, orbitale; *S*, sella turcica; *ANS*, anterior nasal spine; *Pg*, pogonion; *Gn*, gnathion; *Me*, menton; *Go*, gonion; *Ar*, zygomatic arch; *Po*, proion. Point *A* is the most retruded portion on the premaxilla; point *B* is the deepest point of the mandibular bony profile.

mandibular bony profile (B point); the most anterior point on the bony chin or pogonion (Pg); the center of the inferior contour of the bony chin or gnathion (Gn); the most inferior point on the bony chin or menton (Me); the midpoint at the angle of the mandible or gonion (Go); the point at the intersection of the posterior border of the mandibular ramus and the shadow of the zygomatic arch (Ar); and the porion (Po) or midpoint of the upper part of the external auditory canal.

One of the major difficulties in cephalometric analysis is the setting of normal reference standards. An early widely accepted standard was the Downs analysis, based on a post World War II study at the University of Illinois on 25 adolescent whites with ideal dental occlusion.¹⁵ Since then, many studies have been published, including the Michigan Growth Study⁵⁷ and the Bolton Study in Cleveland.⁶

There are multiple cephalometric systems that use different linear distances between points or angles between lines to analyze faces. In essence, they are all attempting to relate the five major functional components of the face to each other, both horizontally and vertically. These components are shown in Figure 27-21: the cranium and cranial base, the skeletal maxilla (maxilla minus teeth and alveolar process), the skeletal mandible (again minus teeth and alveolus), the maxillary dentition, and the mandibular dentition.

The Steiner analysis developed in the 1950s was the



FIGURE 27-21. Five major functional components of the face. *1*, cranium and cranial base; *2*, skeletal maxilla; *3*, skeletal mandible; *4*, maxillary dentition; *5*, mandibular dentition.

first hard tissue cephalometric analysis to be widely accepted.⁶² Because it is still commonly used, a few of its components will be described to illustrate the approach taken by many of the systems. The first measurement is of the angle SNA, which describes the anteriorposterior relationship of the maxilla to the cranial base (SNA is usually $82^{\circ} \pm 2^{\circ}$). Thus, an SNA angle greater than 84° would imply maxillary protrusion, and an angle less than 80°, maxillary recession. The second measurement is the SNB, which measures the relationship of the mandible to the skull base (SNB is normally $78^{\circ} \pm 2^{\circ}$). A similar interpretation of a large or small SNB angle is made as is for SNA (i.e., a SNB angle greater than 80° implies mandibular prominence, and an angle less than 76°, mandibular recession). The ANB angle is the difference between the SNA and SNB angles and represents the difference in relative positions between maxilla and mandible (ANB is normally $2^{\circ} \pm 1.5^{\circ}$). The ANB angle, however, is also influenced by the vertical height of the face and the anterior-posterior placement of the nasion. Next in the Steiner analysis, the angle of the upper incisor to the NA line (normal 22°) and the lower incisor to the NB line (normal 25°) as well as the distance from the incisal edge to the lines is measured. The relative position of the chin (pogonion) to the lower incisor is important; a relatively prominent incisor allows a more prominent chin and vice versa. Finally, the angle between the mandibular plane (Go-Gn) and SN gives a measure for the vertical proportions of the face; the normal value for this angle for whites is 32°.

Soft-Tissue Cephalometric Analysis

Holdaway has been a strong advocate of soft-tissue cephalometric analysis:^{32,33}

Because of the fundamental information that can be recorded in a hard-tissue cephalometric analysis, there are few of us who do not use a cephalometric approach today. There is additional information which can be taken from a study of structures in the integumental covering of the hand. Tissues that we should recognize as being each more important. This is the soft-tissue approach to treatment planning.

Many of the points relating to the soft-tissue profile are defined similarly. Some of the major points used to define the soft-tissue facial profile are seen in Figure 27-22. The soft-tissue Frankfort horizontal (FH) is defined as the horizontal line extending from the superior border of the external auditory canal to the inferior border of infraorbital rim. The glabella (G) is the most prominent point in the midsagittal plane of the forehead. The nasion (N) is the deepest depression at the root of the nose in the midsagittal plane. The rhinion (R) represents the junction of the bony and cartilaginous dorsum and is usually the maximal hump on the nose. The tip (T) is the most anterior projection of the nose.



FIGURE 27-22. Major points in soft-tissue cephalometric analysis. G, glabella; N, nasion; R, rhinion; Tr, tragion; T, tip; CM, columella; SN, subnasale; LS, labrale superius; LI, labrale inferius; STMS, stomion superioris; STMI, stomion inferioris; Pg, pagonion; Me, menton; C, cervical point; SI, suleus inferioris.



FIGURE 27-23. The aesthetic triangle of Powell and Humphreys. Ideal measurements for the male face are shown for the nasofrontal angle (*NFr*), the nasofacial angle (*NF_a*), the nasomental angle (*NM*), and the mentocervical angle (*MeC*).



FIGURE 27-24. (**A**) Mean values for the nasal (Na), maxillary (Mx), and mandibular (Mn) angles of Peck and Peck. (**B**) Mean values for the facial (F), maxillofacial (MF), and nasomaxillary (NM) angles of Peck and Peck.

The columella point (CM) is the most anterior soft tissue point on the columella. The subnasale (Sn) is the junction of the columella with the upper cutaneous lip. The labrale superius (LS) represents the mucocutaneous junction of the upper lip at the midsagittal plane. Similarly, the stomion superioris (STMS) represents the lower border of the upper lip at the midsagittal plane. The stomion inferioris (STMI) and labrale inferius (LI) are similarly described for the lower lip. The sulcus inferioris (SI) represents the deepest depression in the concavity between the lip and the chin. The pogonion (Pg) is the most anterior point on the chin. The menton (Me) is the lowest point on the contour of the soft tissue chin. The cervical point (C) represents the junction between the submental area and the neck. The tragion (Tr) is the point at the superior aspect of the tragus.

Representative soft-tissue cephalometric systems include those of Powell and Humphreys,⁵¹ Peck and Peck,⁴⁸ and Holdaway.^{32,33} Powell and Humphreys describe their "aesthetic triangle," and believe the following measurements (female/male) are ideal (Fig. 27-23):

- Nasofrontal angle (NFr) 120°/115°
- Nasofacial angle (NFa) 36°/36°
- Nasomental angle (NM) 130°/130°
- Mentocervical angle (MeC) 85°/80°

Peck and Peck describe a nasal angle (Na) that measures the nasal height from nasion to tip, a maxillary angle (Mx) which measures the maxillary height from the tip to the labrale superius, and a mandibular angle (Mn) which records the mandibular height from the labrale superius to the pogonion (Fig. 27-24A). In their study, the mean values for these angles in healthy adults were 23.3°, 14.1°, and 17.1° respectively. Peck and Peck then describe a unique orientation plane (Fig. 27-24B). A single line is dropped from the nasion to the pogonion. A line drawn from the tragion to the midpoint of this line forms a new orientation plane. The point where these lines cross describes a facial angle (F), whose mean value in aesthetically pleasing individuals is 102.5°. The maxillofacial angle (MF) is determined by extending another line from the nasion to the labrale superius. This angle relates the upper lip to the chin, and a mean value in aesthetically pleasing adults was 5.9°. A final line is drawn from the labrale superius to the nasal tip. The angle between this line and the orientation plane is the nasal maxillary angle (NM) and relates the upper lip to the nasal tip. Its mean value was 106.1°.

Holdaway describes his harmony line, or *H line*, which extends from the pogonion to the most prominent part of the upper lip (Fig. 27-25). The soft-tissue facial line that runs from the soft-tissue nasion to the pogonion meets the H line to create the *H angle*. A normal H angle is 10° , and a larger angle relates to increasing soft-tissue profile convexity. This system relates the H line to many of the standard hard- and soft-tissue points noted previously. In addition to the soft-tissue cephalometric measurements noted above, there are various graphic means to directly compare patient profiles to standards. Although these techniques lack



FIGURE 27-25. The H angle of Holdaway.

precision, they do allow one to see where a facial pattern departs from normal form.

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