Special Topic

Clinical Anthropometry and Canons of the Face in Historical Perspective

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Measurements of the human face as part of the body have been performed since the Greek era, and many aspects of ancient measurements can be found in modern clinical anthropometry. A historical appraisal of the use of facial measurements is presented. The influence on modern facial anthropometry of Greek proportion sciences, the golden proportion, canons of important Renaissance artists, physical anthropology, and cephalometry are discussed. The main difference between human measurements in classic times and modern anthropometry is the denial of realistic sizes and proportions in former times. Human forms and canons were depicted in a way the artist or scientist preferred, rather than how they objectively were. For reconstructive and cosmetic surgery, realistic sizes and proportions are assessed using anthropometric techniques and used as guidelines to correct deformities or disproportions. (*Plast. Reconstr. Surg.* 106: 1090, 2000.)

Man is constantly striving to improve his fate. We have been, and still are, trying to undo or correct congenital, developmental, traumatic, and surgical shortcomings and deformities. Using facial, craniofacial, and maxillofacial surgical techniques, our goal is to obtain aesthetically superior results for our patients. To judge the appeal of a patient's face, it is compared with beauty norms that today are well defined by canons or anthropometric proportions. The availability of values for facial sizes and proportions enables us to reproduce cosmetically attractive proportions for our patients.

Body measurements were used by the Egyptians, but facial measurements were first performed by the Greeks as part of total body measurements. The reasons to perform these measurements have not always been the same. Some investigators have used measurements on human beings to imply certain groups of people to be superior, whereas others applied such measurements to create art of ultimate beauty. A common element of anthropometry of all times is that man has tried to catch physical proportions into values. Still, only a few centuries ago, human features and canons were not realistically acknowledged. This can be deducted from classic works of art and science in which the subjects were depicted the way the artist or scientist preferred them, rather than how they really were.

In this article, an overview of the influential contributors to modern facial anthropometry and the use of facial measurements are presented.

Pre-Renaissance: Toward Body Measurements and Canons

Egyptians

The principles for the canons of the human body may have been defined by Egyptian artists, who were alleged to have heavily influenced the Greeks and Romans.[1] Egyptian artisans depicted human figures as we still know them today—erect with legs and head in a lateral view and the shoulders in the anterior view. They divided the available space from top to bottom in 22.25 like parts to fit the human figure. It is suggested that the Egyptians took the middle finger to be one-nineteenth of the adult man's length. Still, well-defined landmarks—such as the nipples, umbilicus, and knees—were not localized along these divisions; therefore, Snijder[1] denied the existence of any standards in Egyptian art. He alleged that the Egyptians did not use a line system to measure parts of the human body in relation to others, and he concluded that no canons could be derived from their art.

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Greeks

Polycleitus (c.450–c.420 BC) was a Greek sculptor who was obsessed with the beauty of male athletic bodies. Even though his study of the ideal physical proportions was probably based on Egyptian principles, he seemed to have been the first to define canons.[1] He reported the height of the face to be one-tenth of the length of the body and the whole head one-eighth of it. Head and neck together were to be one-sixth of the length of the athlete. He expressed his ideas on ideal proportions in the statue of Doryphorus that subsequently was copied many times because of its beauty (Fig. 1).

Aristotle

Aristotle (384–322 BC) strived to put the cosmos into an order with man at its top by observing and philosophizing about how to interpret his observations.[2] Part of his very extensive work deals with the human body and face. He emphasized the proportions of aesthetics, but also used his observations on human structure to try and prove that certain groups of people were superior to others. In his *Physiognomica,* Aristotle described the science of reading one's character from one's bodily features.[3] He compared male and female bodies and faces to those of various animals and, from this comparison, he deducted their character. He found males to look like brave lions because of the larger mouth, squarer face, equally balanced jaws, bright, deep-set eyes, large eyebrows, and square forehead. Women were, in his opinion, more like shy panthers. Likewise, Aristotle's *Historia Animalium* is a combination of descriptions of features and judgments regarding the alleged qualities of people with these features.[4] Because no exact physical measurements are found in his books, Aristotle's work may be called "facial anthropometry avant la lettre."

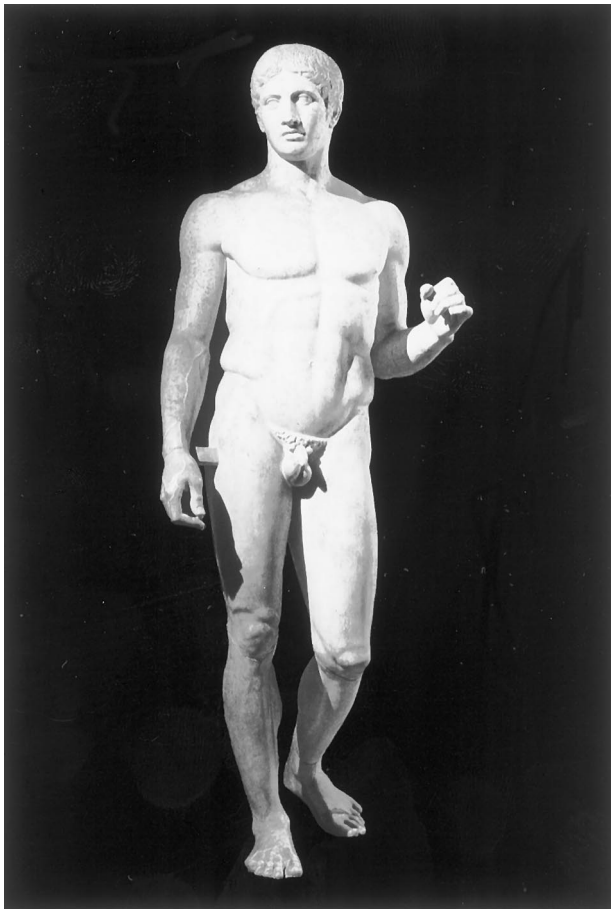

FIG. 1. In his sculpture of Doryphorus, Polycleitus expressed his concept of the ideal canons and proportions of the male body.

RENAISSANCE: TOWARD IDEAL FACIAL PROPORTIONS

Da Vinci

Leonardo Da Vinci (1452–1519) extensively reported on the proportions according to which bodies and faces should ideally be shaped, and he applied these canons in his art. Moreover, his famous "human figure in a circle" illustrates the proportions recorded by the Roman author Vitruvius. According to Da Vinci, in a well-proportioned face, the size of the mouth equals the distance between the parting of the lips and the edge of the chin (Fig. 2), whereas the distance from chin to nostrils, from nostrils to eyebrows, and from eyebrows to hairline are all equal, and the height of the ear equals the length of the nose.[5,6] Even though he dictated these strict canons for facial and bodily proportions, Da Vinci could not deny the natural variations of nature. After all, he did his measurements on live bodies and compared the sizes of various parts of these bodies to one another.[5]

Dürer

Albrecht Dürer (1471–1528) also felt that a system of canons could be devised that would define the ideal proportions for human figures and heads. These, in turn, would result in the most beautiful figures.[7,8] His findings were also meant to provide guidelines to other painters. After experimenting on paper with sizes and proportions, he—like Da Vinci—came to rec-

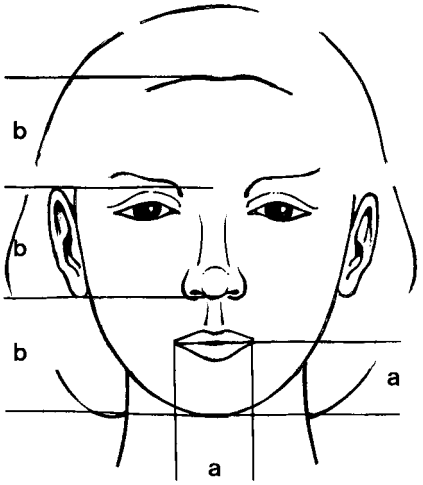

FIG. 2. According to Da Vinci, in a well-proportioned face, the size of the mouth equals the distance between the parting of the lips and the edge of the chin (*a*), whereas the distance from chin to nostrils, from nostrils to eyebrows, and from eyebrows to hairline are all equal (*b*), and the height of the ear equals the length of the nose.

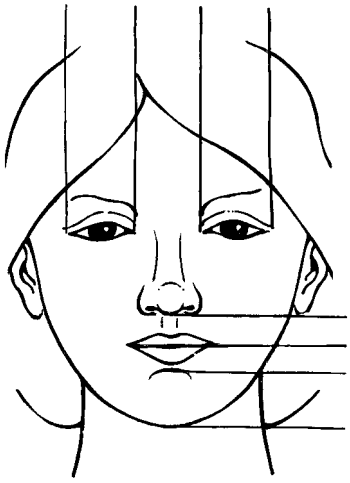

FIG. 3. Like Da Vinci, Dürer preferred to divide the face into three equal lengths: the forehead, nose, and the mouth and chin. The latter part he divided into four equal parts, with the parting of the lips one-fourth from the top and the mental sulcus halfway between the nostrils and the edge of the chin. He also found the width between the eyes to equal the size of one eye.

ognize that the face was divided into three equal lengths: the forehead, the nose, and the mouth and chin (Fig. 3).[9,10] He divided the latter part into four equal parts, with the parting of the lips one-fourth from the top, and the mental sulcus halfway between the nostrils and the edge of the chin. He found further that the width between the eyes equaled the size of one eye.[11] Even though Dürer felt aberrations from his canons to be unaesthetic, most of the heads he painted are unattractive to our eyes.[8]

EIGHTEENTH AND NINETEENTH CENTURIES: TOWARD PHYSICAL ANTHROPOLOGY

Camper

Physical anthropology has its roots in the 18th and 19th centuries when most of the "facial" measurements were taken directly from skulls and only a few soft-tissue measurements were performed. In this less enlightened era, these measurements were used predominantly to prove that certain groups of people were superior to others. Petrus Camper (1722–1789) tried to counter the leading opinion of his age that black men were more closely related to apes than to white men by proving the close relationship between white and black men, and their mutual difference from the ape. For this, he introduced the facial angle between the horizontal line connecting the lower boundary of the nose and the external opening of the ear, and the facial line from forehead to the edge of the upper teeth.[2,9,12] Camper measured this angle in a large number of skulls of men and apes and found that the larger facial angles were typical for apes, whereas white and black men had smaller facial angles.[12] Together, with his observations on skin texture, this led Camper to conclude that black and white men alike originated from Adam and not from the ape.[12]

De Gobineau, Broca, Topinard, and Lombroso

Unfortunately, assessment of dimensions of the skull have led some other investigators to discriminate between certain races with regard to intelligence and other qualities. Joseph A. de Gobineau (1816–1882) and Paul Broca (1824–1880) believed in inequality as a law of nature and that this included a ranking according to skull contents of superior and inferior humans.[2,13] Because Broca was convinced of the inferiority of all non-white people, he manipulated his results to endorse this hypothesis.[13]

In his voluminous work *Eléments d'anthropologie générale*, Broca's pupil—Paul Topinard (1830–1911)—described how he sometimes performed in vivo measurements in different races.[14] Although most of his studies were done on skulls, he also did measurements of soft-tissue proportions, a small part of which concerned the nasal region. Topinard defined the nasal index, this being the quotient of the width of the nose at its base and the height of the nose. It could be measured in vivo and in

skulls. He presented the values of the nasal index as found in various races and declared people with a larger nasal index to be inferior to people with a smaller index.[14]

Cesare Lombroso (1836–1909) described how gangsters, murderers, alcoholics, fire-raisers, epileptics, and dwarfs could be distinguished from "normal" people by anthropometric assessment of skull shape, asymmetry of the face, shape of nostrils, tooth form, size of the masseter muscle, and size of the frontal sinus.[15] For this purpose, he evaluated the literature on this topic and combined it with his own measurements on skulls and the heads and faces of live people.

Twentieth Century: Toward Objective Measurements and Proportions

Joseph

The father of modern rhinoplasty, Jacques Joseph (1865–1934), strongly emphasized the importance of the nasal profile for the cosmesis of the face. He studied the aesthetics of various inclinations of the nasal bridge, which he measured in relation to the general profile line, rather than to the Frankfurt horizontal. Joseph considered the nose to be divided in three parts: the bony part, the septal cartilaginous part, and the cartilaginous and soft-tissue tip.[16] He equaled the combined length of these three parts, in turn, to the length between the base of the nose and the edge of the chin (Fig. 4). Joseph described the consequences to facial cosmesis of deformities of any of these three parts or the combinations of these, and presented what he considered to be the ideal nasal shape in photographs and drawings.[16]

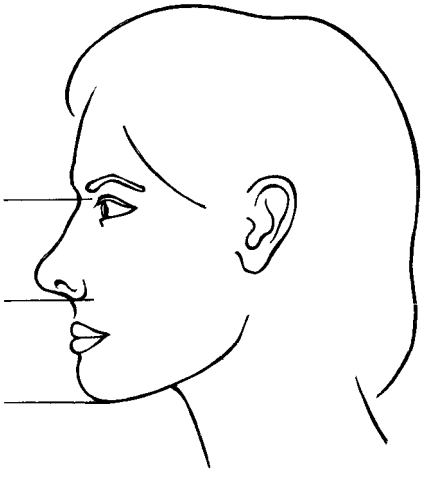

Fig. 4. Joseph equaled the combined length of the three parts of the nose to the length between the base of the nose and the edge of the chin.

Broadbent

During the first decades of the 20th century, pioneering orthodontists initiated the quantitative determination of structural changes in radiograms of the facial skeleton. Cephalometric radiology is a technique using oriented radiographs for the purpose of head measurements, and its principles are patterned closely after those of craniometry, which has long been used in the quantitative study of dried skulls. In 1931, B. Holly Broadbent, Sr. (1894–1977) introduced the basic techniques of cephalometric assessment of living subjects, recording the shadow images of both hard and soft tissues on living, growing, and changing subjects.[17,18] Cephalometry, hence, is an indirect form of facial anthropometry. This new technique became the vital research tool of the Bolton Study, which pursued dentofacial roentgenographic studies of healthy children from birth to adulthood. The ultimate result consisted of 22,800 recordings of 5400 children over a period of 36 years.[19] Another orthodontist, Edmondo Muzj,[20] introduced the frontofacial angle and with it demonstrated the need for harmony and symmetry in horizontal and vertical facial planes.

González Ulloa

By introduction of the concept of profileplasty, Mario González Ulloa (1913–1995)

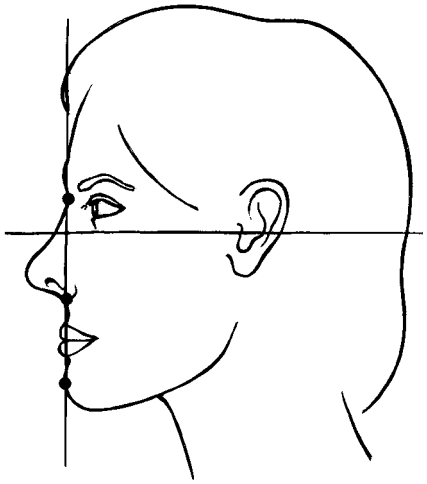

Fig. 5. By introduction of the concept of profileplasty, González Ulloa stressed the importance of the correction of the entire facial profile. He believed that the glabella, subnasal point, and pogonion should be in line ideally, and that this imaginary line should be perpendicular to the Frankfurt horizontal.

stressed the importance of the correction of the entire facial profile.[9,21,22] He felt the glabella, subnasal point, and pogonion should ideally be in line, and that this imaginary line should be perpendicular to the Frankfurt horizontal (Fig. 5). He successfully applied this principle for facial corrections in his Mexican patients, whereas applying it to white patients would not have yielded a satisfactory result.

Ricketts

Even though Seghers et al.[23] introduced the use of the "golden proportion" in facial surgery, it was R. M. Ricketts who popularized the concept.[24–27] The golden proportion was first recorded in the third century BC by the Pythagoreans and later by the Greek geometrician Euclid as the ratio between two portions of a line, or the two dimensions of a rectangular plane, in which the lesser of the two is to the greater as the greater is to the sum of both. Because the Egyptians had applied the golden proportion in their architecture, however, it is assumed that they had already been aware of the aesthetically attractive 1:1.618 ratio.[23,28,29] This golden proportion has been defined as the ratio that is most attractive to the human eye and mind, and the Greek letter phi (ϕ) is used to indicate the number 1.618. A famous example of a building built according to the golden proportion is the Parthenon in Athens.

Ricketts used a golden divider to prove the harmonious faces of beautiful women to be built according to golden proportions (Fig. 6).[25] The golden divider is a sliding caliper with which any given distance can be divided in accordance with the 1:1.618 ratio. Ricketts found the width of the mouth to be ϕ times the nasal. When the width of the mouth is 1, the distance between the outer corners of the eyes is ϕ. The width of the head at the temples, again, is ϕ times the distance between the outer corners of the eyes. Vertically, the height of the forehead from hairline to eye pupils is 1, where the height of the face from pupils to chin is ϕ. A golden proportion may be found when the height of the face from pupils to chin is divided into the distances between pupils and nasal alae on the one hand, and the distance between nasal alae and chin on the other. If the distance between chin and mouth is 1, the distance between the mouth and the pupils, once more, is ϕ. Applying the concept of the golden proportion has been advocated for planning and evaluating treatment in daily practice.[23–27,30]

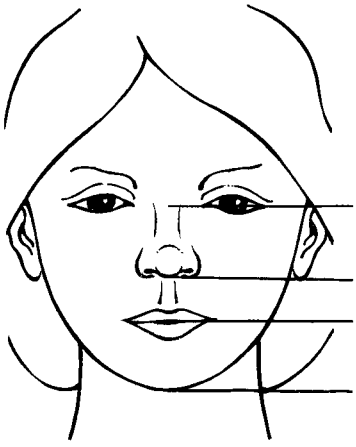

FIG. 6. Ricketts used a golden divider to prove the harmonious faces of beautiful women were built according to golden proportions. Here, the distance from the pupil to the ala is 1, whereas the distance from the ala to under the chin is 1.618. Likewise, the distance from ala to mouth is 1 and from mouth to chin is 1.618.

Farkas

L. G. Farkas should be considered to have influenced, most importantly, modern facial soft-tissue anthropometry. By measuring and comparing more than 100 dimensions and proportions in hundreds of people, he defined standards for almost every soft-tissue measurement in the head and face in more than 120 publications.[31,32] Part of his extensive work is on lateral facial dysplasia and cleft lip and palate. He defined the role of anthropometry in the evaluation of these disorders.[33–35] In addition, he published on the aesthetics of women's faces[11] and revised the classic canons for facial proportions in art to correlate these to current norms.[10,36]

DISCUSSION

Even though many aspects of the classic anthropometry still prove useful in modern anthropometry, these measurements are no longer applied to discriminate allegedly inferior people. Modern anthropometry mainly serves forensic and medical purposes, with the evaluation of deformities and growth in cleft patients being an example of the latter. It also provides a less subjective base for the planning and evaluation of maxillofacial surgery and conservative and surgical orthodontics.

When considered in a historical perspective, some of the canons of beauty seem to be in agreement with each other. As for the canons in the oral and nasal areas, for example, Da

Vinci divided the head into two equal parts from top to nasal root and from nasal root to chin,[6,10,37] or the face into three equal parts, respectively, ranging from hairline to nasal root, from nasal root to nasal base, and from nasal base to the edge of the chin.[37,38] Dürer also applied the latter canon.[8,11] A third canon dividing the head into four equal parts from top of the head to the hairline, from hairline to nasal root, from nasal root to base, and from nasal base to chin, respectively, was described by Audran (1640–1703) who deducted it from his measurements of the finest figures of antiquity.[10,37] Even though all three of these canons correlate, Farkas found these proportions only to be present incidentally in a group of more than 100 white Americans.[10,36] The same applies to the golden proportion; only in the faces of a highly selected group of humans can such proportions be found.[25]

In our opinion, these canons in themselves do not have a great practical value because using them denies the individual differences observed in normal or even attractive people. It is more practical to compare a patient's anthropometric values to the range of values found in a large group of normal subjects.[32] Even though measuring the face can never replace the intuitive judgment by the human eye, it may offer additional guidelines in our clinical work.[39] Still, the cogency of Bacon's[40] argument that "there is no excellent beauty that hath not some strangeness in the proportion" remains irrefutable.

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REFERENCES

1. Snijder, G. A. S. *Het Ontstaan van den Proportie-kanon bij de Grieken.* Utrecht, The Netherlands: Oosthoek, 1928. Pp. 5–41.
2. de Froe, A. *Inleiding tot de Studie en Beoefening der Anthropologie.* Amsterdam: Noord-Hollandsche Uitgevers Maatschappij, 1948. Pp. 44–94.
3. Heinemann, W. *Aristotle—Minor Works: Physiognomics.* Cambridge, Mass.: Harvard University Press, 1963. Pp. 83–137.
4. Aristoteles. *The Works of Aristotle—Volume IV: Historia Animalium.* Oxford: Clarendon Press, 1949.
5. McMurrich, J. P. *Leonardo Da Vinci: The Anatomist.* Baltimore: Williams & Wilkins, 1930. Pp. 104–110.
6. McCurdy, E. Human Proportions. In E. McCurdy (Ed.), *The Notebooks of Leonardo Da Vinci*, Vol. 1. London: Reprint Society, 1954. Pp. 197–204.
7. Lionnois, L. M. *Les Quatre Livres d'Albert Dürer.* Paris: Les editions Roger da Costa, 1613.
8. Strauss, W. L. *The Complete Drawings of Albert Dürer—Volume 5: Human Proportions.* New York: Abaris Books, 1974. Pp. 2407–2408.
9. González Ulloa, M. Quantitative principles in cosmetic surgery of the face (profileplasty). *Plast. Reconstr. Surg.* 29: 186, 1962.
10. Farkas, L. G., Hreczko, T. A., Kolar, J. C., and Munro, I. R. Vertical and horizontal proportions of the face in young adult North American Caucasians: Revision of neoclassical canons. *Plast. Reconstr. Surg.* 75: 328, 1985.
11. Farkas, L. G., and Kolar, J. C. Anthropometrics and art in the aesthetics of women's faces. *Clin. Plast. Surg.* 14: 599, 1987.
12. van Bork-Feltkamp, A. J. Life and Work of Petrus Camper. In A. J. van Bork-Feltkamp (Ed.), *Anthropological Research in the Netherlands.* Amsterdam: Noord-Hollandsche Uitgervers Maatschappij, 1938. Pp. 8–15.
13. Gould, S. J. *The Mismeasure of Man.* St. Ives, U.K.: Clays, 1981. Pp. 73–112.
14. Topinard, P. *Elements d'Anthropologie Generale.* Paris: Delahaye & Lecrosnier, 1885. Pp. 244–307.
15. Lombroso, C. *L'Anthropologie Criminelle.* Paris: Alcan, 1890. Pp. 26–74.
16. Joseph, J. *Nasenplastik und Sonstige Gesichtsplastik.* Leipzig, Germany: Curt Kabitzsch, 1931. Pp. 4–26.
17. Broadbent, B. H. A new X-ray technique and its application to orthodontia. *Angle Orthod.* 1: 45, 1931.
18. Broadbent, B. H. The face of the normal child. *Angle Orthod.* 7: 183, 1937.
19. In Memoriam—B. Holly Broadbent, D.D.S. *Angle Orthod.* 48: 172, 1978.
20. Muzj, E. Musical and architectural proportions in the anatomy of the facial system: An anthropometric approach. *Angle Orthod.* 52: 177, 1982.
21. González-Ulloa, M. A quantum method for the appreciation of the morphology of the face. *Plast. Reconstr. Surg.* 34: 241, 1964.
22. González-Ulloa, M. Aesthetic Evaluation of the Face: Profileplasty. In B. L. Kaye and G. P. Gradinger (Eds.), *Symposium on Aesthetic Surgery of the Nose, Ears, and Chin.* St. Louis: Mosby, 1984. Pp. 35–44.
23. Seghers, M. J., Longacre, J. J., and deStefano, G. A. The golden proportion and beauty. *Plast. Reconstr. Surg.* 34: 382, 1964.
24. Ricketts, R. M. Esthetics, environment, and the law of lip relation. *Am. J. Orthod.* 54: 272, 1968.
25. Ricketts, R. M. The golden divider. *J. Clin. Orthod.* 15: 752, 1981.
26. Ricketts, R. M. The biologic significance of the divine proportion and Fibonacci series. *Am. J. Orthod.* 81: 351, 1982.
27. Ricketts, R. M. Divine proportion in facial aesthetics. *Clin. Plast. Surg.* 9: 401, 1982.
28. Pacioli, F. L. *Divina Proportione.* Wien: Carl Grasner, 1889. Pp. 296–306.
29. Huntley, H. E. *The Divine Proportion.* New York: Dover, 1970. Pp. 50–69.

30. Levin, E. I. Dental esthetics and the golden proportion. *J. Prosthet. Dent.* 40: 244, 1978.
31. Farkas, L. G. Results. In L. G. Farkas and I. R. Munro (Eds.), *Anthropometric Facial Proportions in Medicine.* Springfield, Ill.: Charles C Thomas, 1987. Pp. 155–319.
32. Farkas, L. G. *Anthropometry of the Head and Face,* 2nd Ed. New York: Raven Press, 1994. Pp. 21–25.
33. Farkas, L. G., Ross, R. B., and James, J. S. Anthropometry of the face in lateral dysplasia: The bilateral form. *Cleft Palate J.* 14: 41, 1977.
34. Farkas, L. G., and James, J. S. Anthropometry of the face in lateral dysplasia: The unilateral form. *Cleft Palate J.* 14: 193, 1977.
35. Farkas, L. G., Hajnis, K., and Posnick, J. C. Anthropometric and anthroposcopic findings of the nasal and facial region in cleft patients before and after primary lip and palate repair. *Cleft Palate Craniofac. J.* 30: 1, 1993.
36. Farkas, L. G., Sohm, P., Kolar, J. C., Katic, M. J., and Munro, I. R. Inclinations of the facial profile: Art versus reality. *Plast. Reconstr. Surg.* 75: 509, 1985.
37. Boyd, E. Renaissance Europe (A.D. 1400–1600). In B. S. Savara and J. F. Schilke (Eds.), *Origins of the Study of Human Growth.* Portland, Ore.: University of Oregon Health Sciences Center, 1980. Pp. 167–315.
38. Kelen, E. *Leonardo da Vinci's Advice to Artists.* Nashville, Tenn.: Thomas Nelson, 1974. Pp. 27–73.
39. Furnas, D. W. Foreword. In L. G. Farkas (Ed.), *Anthropometry of the Head and Face.* New York: Raven, 1994. P. xvii.
40. Bacon, F. Of Beauty. In *The Essays or Counsels Civil and Moral by Francis Bacon.* Leipzig, Germany: Bernhard Tauchnitz, 1919. Pp. 163–164.