Facial Anthropometric Measurements and Principles – Overview and Implications for Aesthetic Treatments

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Abstract

Facial anatomy is highly individual in each patient. Anthropometric measurements can be a useful tool to objectively analyze individual facial anatomy to allow for better comparability before and after treatments to ultimately improve standardization of facial procedures, both nonsurgical and surgical. The aim of this study was to provide a comprehensive overview over clinically relevant and feasible facial anthropometric measurements and principles for aesthetic medicine. A literature review was conducted to describe the most important and clinically relevant anthropometric measurements and principles for both the entire face and for three aesthetically relevant facial regions: the periorbital region, the nose, and the perioral region. A multitude of different anthropometric measurements and principles have been described in the literature for both the overall facial appearance and specific facial regions. Certain generally accepted anthropometric principles and proportions need to be respected to achieve aesthetic and harmonious results. For the overall facial appearance, a focus on symmetry, certain proportions, facial angles, and indices has been described. Principles and measurements were also described for the periorbital region, the nose, and the perioral region. Although attractiveness and aesthetic perception are subjective, objective evaluation of facial surface anatomy via anthropometric measurements can improve pre- and postinterventional analysis of the face and help the treating physician to individualize treatments, both nonsurgical and surgical.

Keywords
- facial anthropometry
- anthropometric measurements
- aesthetic procedures
- facial anatomy
- facial landmarks

The face is considered the key body region when it comes to the perception of aesthetics and attractiveness. Within a blink of a second, a face can individually be regarded as attractive or unattractive.[1,2] In recent years, the restoration and accentuation of youthful and harmonious facial proportions has become increasingly more demanded with a great spike in the number of performed aesthetic procedures, both nonsurgical and surgical.[3,4] Over time, the complex biomechanical interplay of different facial tissues such as bone, muscles, fat compartments, and ligaments all leads

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to typical characteristics of an aged face such as wrinkles, folds, and jowls.[5,6] Therefore, the face holds particular challenges for these aesthetic treatments as the craniofacial complex is a three-dimensional structure with great morphological and functional variability of different tissues and facial regions. Due to the anatomical complexity of this body region and the treatment challenges that go along with it, objective facial measurements can pose a useful tool for the treating physician. Anthropometric measurements for the analysis of facial surface anatomy comprise—among others—distances, relationships, ratios, and lines. These tools allow objective evaluation of the face before and after the treatment and to ultimately improve and standardize treatments.

Although there is no such thing as a perfect face and attractiveness is subject to the spectator, certain facial features, proportions, and ratios are generally accepted to be strongly associated with positive attributes such as attractiveness and an overall harmonious facial appearance. For instance, a strongly defined jawline is associated with masculinity, attractiveness, and trustworthiness.[7–9] Also facial symmetry—among other factors—has been often reported to play an integral role for an overall harmonious facial appearance.[10–12] Still, objective anthropometrical measurements and principles should merely be seen as a tool for physicians to individualize treatments as the perception of beauty and attractiveness remains subjective and nonquantifiable.

While treating specific facial regions, physicians should at all times keep in mind that the treatment of a single facial region can result in an overall changed appearance of the entire face.[13,14] Therefore, both the entire face (e.g., facial convexity angle) in general and specific facial areas (e.g., lips and nose) should be evaluated thoroughly and independently using anthropometric examination.

Profound knowledge of basic aesthetic principles, facial anatomy, the interplay between facial regions, and quantifiable anthropometric measurements of the face is required to achieve best possible results and highest possible levels of patient satisfaction. In the following review, the authors focused on the description of clinically relevant and feasible anthropometric measurements and principles for both the overall facial appearance and aesthetically relevant specific facial regions such as the periorbital region, the nose, and the perioral region.[15–17]

Materials and Methods

Anthropometrical Measurement Methods

Anthropometry is defined as the measurement of the size and proportions of the human body and its different parts.[18] Various methods have been described to conduct anthropometrical measurements.

The direct anthropometrical examination of the face can be performed using basic instruments such as a tape measure, a Vernier caliper, and a Martin-Breadth caliper. Using these instruments, a multitude of different facial anthropometric measurements can be performed. (e.g., facial index measurements using the Martin-Breadth caliper). Although anthropometric measurements can be performed with ease directly in a live clinical setting, it remains time-consuming, is prone to measurement errors, and thus shows poor reproducibility.[19–21]

Photogrammetry allows one to perform standardized two-dimensional facial analysis for the measurement of distances, angles, indices, or proportions and is usually done indirectly in standardized photographs taken in a frontal, profile, and oblique angle. The measurements must then be related to an appropriate scale to relate the measurements obtained in the photograph with the "real-life" scale. This method allows for better reproducibility than direct anthropometrical measurements but accuracy depends greatly on the photography setup.[22]

The most recent method to perform anthropometrical measurements adds another dimension to photogrammetry and is called stereophotogrammetry.[23–26] Stereophotogrammetry allows analysis of the three-dimensional surface of the face. This method offers a high degree of measurement precision ensuring high reproducibility of obtained measurements and allows for follow-up images for comparison. Three-dimensional photographs of the face are generated by combining ("stitching") two-dimensional photographs, obtained either from multiple cameras placed at different angles (multicamera systems) simultaneously or mobile 3D cameras.[27,28] The subject's face is then converted into a series of coordinates with an x, y, and z definition in a three-dimensional coordinate system. Prominent facial landmarks are identified automatically by the respective image analysis software. Due to the fact that all two-dimensional photographs are taken at the same time in multiple-camera systems, more precise surface scans can be generated as subjection motion is not an issue. When using the mobile 3D camera, the face is typically photographed in three different angles: frontal, 45 degrees left, and 45 degrees right. These photographs are then stitched in the proprietary software to generate a three-dimensional surface scan. While taking the photographs with a mobile 3D camera, the subject can move during the positional changes of the photographer and therefore reduce the quality and accuracy of the three-dimensional surface scan.[29,30] Overall, stereophotogrammetry enables the physician to capture the entire face quickly and measure distances with an appropriate scale. Furthermore, volumetric changes and skin displacement vectorial analysis can be performed.[27,31,32]

Besides being helpful for analyzing the facial skin surface, anthropometric measurements are also of utmost importance in the evaluation of the facial skeleton in the field of orthognathic surgery as the surgeon is aiming to improve facial aesthetics and dental occlusion by implementing anthropometric measurements.[33,34] Typically, frontal and lateral cephalograms as well as cone beam computed tomography scans are used for surgical planning and comparison before and after surgery. This analysis can be performed based on two-dimensional or three-dimensional images.[35,36]

Craniofacial Position and Planes

To perform standardized anthropometrical measurements of the face, reference positions and planes of the craniofacial complex need to be defined. The measurements and principles presented in this overview are based on the *rest position* and the *Frankfurt horizontal plane*.

The *rest position*, also termed *natural head position*, is not a standardized head position per se as it is the natural, comfortable position adopted by the subject at rest; therefore, it can be regarded as the physiological head position of the individual. This varies greatly from person to person and is dependent on the individual's height and social factors.[37] If not further specified, this position is used for most angular and linear anthropometrical measurements.

The *Frankfurt horizontal plane* is a standardized plane connecting the horizontal lines spanning between the lowest point of the infraorbital rim and the porion (also called ear canal). This plane is supposed to be parallel to the ground and enables the physician to take standardized pre- and post-interventional images of the patient. Furthermore, this plane can also be used as a reference for anthropometrical measurements (►**Fig. 1**).

Important Anthropometrical Measurements

As there are countless different anthropometrical measurements and principles of the face, the authors decided to focus on the ones they deem clinically relevant. For this, we focused on the full face as well as on three facial regions with great aesthetic importance: the periorbital region, the nose, and the perioral region. All measurements analyzed in this study are summarized in ►**Table 1**.

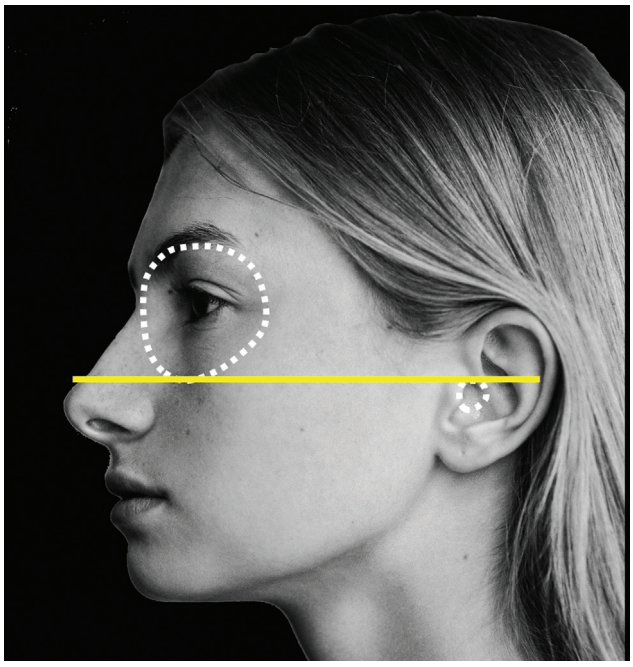

Fig. 1 Photograph of a female model showing the Frankfurt horizontal plane (*yellow line*), which is defined as a horizontal line spanning between the lowest point of the infraorbital rim and the highest point of the ear canal.

Results

Anthropometrics of the Full Face

Facial Symmetry

Facial symmetry has been shown in previous literature to be associated with attractiveness and is therefore one of the main pillars in the perception of facial aesthetics.[10–12] The facial symmetry can semiobjectively, yet effectively, be assessed utilizing the midsagittal plane, which allows comparison of both facial halves. Being perpendicular to the Frankfurt horizontal plane, this plane can be understood as the sagittal extension of the midline. A symmetrical face is defined by equal distances of facial components on both sides to the midline.

Facial Proportions

The face can be divided vertically into three thirds. The upper third is defined between the borders of trichion (i.e., hairline) cranially and the glabella caudally and therefore consists of the forehead and the upper aspects of the periorbital region. The middle third is defined between the borders of the glabella cranially and the subnasale caudally and holds the lower aspects of the periorbital region and the nose. The lower third is defined between the borders of the subnasale cranially and the menton caudally. Furthermore, the face can also be divided horizontally, into five fifths. The most lateral fifth is bordered laterally by the postaurale (i.e., the most posterior point on the helix) and medially by the lateral canthus. The second most lateral fifth is bordered by the lateral canthus laterally and by the medial canthus medially. The most medial fifth is bordered by the medial canthus on both sides. It has been described previously that the length of these vertical thirds and horizontal fifths should be equal in an aesthetic face (►**Fig. 2**).

Also, it was reported that the *golden ratio* (i.e., 1.618) serves as a useful ratio for aesthetic facial proportions. The facial length (i.e., distance between trichion and menton) should be 1.618 times longer than the facial width (i.e., distance between zygomas on both sides). The distance between the trichion and the most lateral point of the nostril ("upper aspect of the face") should ideally be 1.618 times as long as the distance between the most lateral point of the nostril and the menton ("lower aspect of the face"). The golden ratio can also be applied in the lower face where the distance between the lateral canthus and stomion should be 1.618 times as long as the distance between stomion and menton[38,39] (►**Fig. 3**).

Facial Indices

When analyzing the full face, facial indices can play an important role in understanding the proportions and relationship of different facial components. Especially useful for the overall facial appearance are the *facial index* and the *mandible facial index*.

The *facial index* (also called *prosopic index*) is defined as the ratio between facial height (i.e., distance between trichion and pogonion) and facial width (i.e., distance between

Table 1 Summary of all anthropometric measurements and principles analyzed in this study

Measurement/principle	Description
Full face	
Facial symmetry	Comparison of both facial halves utilizing the midsagittal plane
Facial proportions	Division of the face in three equal vertical thirds and five equal horizontal fifths Golden ratio (i.e., 1.618) as an indicator for aesthetic facial proportions
Facial indices	Facial index: ratio between facial height and facial width Mandible-facial index: ratio between facial width and mandibular width
Facial angles and profile analysis	Facial contour angle: glabella – subnasale – pogonion Total facial convexity angle: Glabella – Pronasale - Pogonion
Orthognathic measurements	Angle's malocclusion classification: Classes I, II, and III
Periorbital region	
Margin reflex distance	Distance between light reflection of light source in pupil and the margin of the upper eyelid (MRD-1) and lower eyelid (MRD-2)
Interpupillary distance	Distance between the two pupils in primary gaze position
Outer and inner canthal distance	Distance between bilateral lateral canthus (outer canthal distance) and bilateral medial canthus (inner canthal distance)
Canthal index	Ratio between inner canthal distance and outer canthal distance multiplied by factor 100
Horizontal/vertical palpebral aperture	Horizontal palpebral aperture: distance between medial and lateral canthus Vertical palpebral aperture: distance between the margins of the upper and lower eyelid in the midpupillary line
Palpebral slant (angle)	Relative position of the lateral canthus to the medial canthus
Eyelid height	Distance between the lower margin of the upper eyelid and the eyelid crease
Upper lid ratio	Ratio between the pretarsal show and the preseptal show
Nose	
Symmetry	Comparison of the nasal structures (e.g., nose tip, alar wings, nostrils) utilizing the midsagittal plane
Nasal width and length	Nasal width: distance between both alae Nasal length: distance between nasion and pronasale
Nasal index	Ratio between nasal width and nasal length
Farkas' nostril classification	Classification based on the angle between both nostril axes
Tip-to-nostril ratio and nasal tip projection	Tip-to-nostril ratio: described to be ideal at a ratio of 1:2 Nasal tip projection: 50–60% beyond the most anterior point of the upper lip
Nasofrontal angle	Intersection of two lines tangent to the glabella and the nasal dorsum at the nasion
Nasolabial angle	Intersection of two lines connecting the labiale superius with the subnasale and the subnasale with the columella
Nasomental angle	Intersection of two lines connecting the nasion with pronasale and the nasion with the pogonion
Perioral region	
Labial index	Ratio between labial height and labial width
Philtrum-labial index	Ratio between labial length and philtrum height
Steiner's line (S1 line)	Connecting the pogonion and the middle of the "S-curve," which is formed by the convexity of the nasal tip and the concavity of the upper lip. Lips should have their anterior projection on this line
Rickett's line (E line)	Connecting the pogonion and pronasale. Anterior projection of the upper lip and lower lip should be 4 and 2 mm beyond this line, respectively
Riedel plane	Plane tangent to the anterior projection of both lips allowing to evaluate the relationship between the anterior projection of the lips and the chin
Burstone's line (B line)	Connecting the subnasale and the pogonion. The anterior projection of the upper lip should be 1.6:1 in relation to the lower lip
Sushner's line	Connecting the nasion and pogonion allowing to conduct distance measurements between this line and the anterior projection of the upper and lower lip
Merrifield "Z" angle	Angle between a line connecting pogonion and the most anteriorly projected lip and the Frankfurt horizontal plane
Harmony line (H-line) and H-angle	H-line: connecting the pogonion and the most anteriorly projected part of the upper lip H-angle: intersection between the nasion-pogonion line and the H-line

Fig. 2 (**A**, **B**) Photographs of a female model showing how an aesthetically pleasing face can be separated in three equal vertical thirds and five equal horizontal fifths.

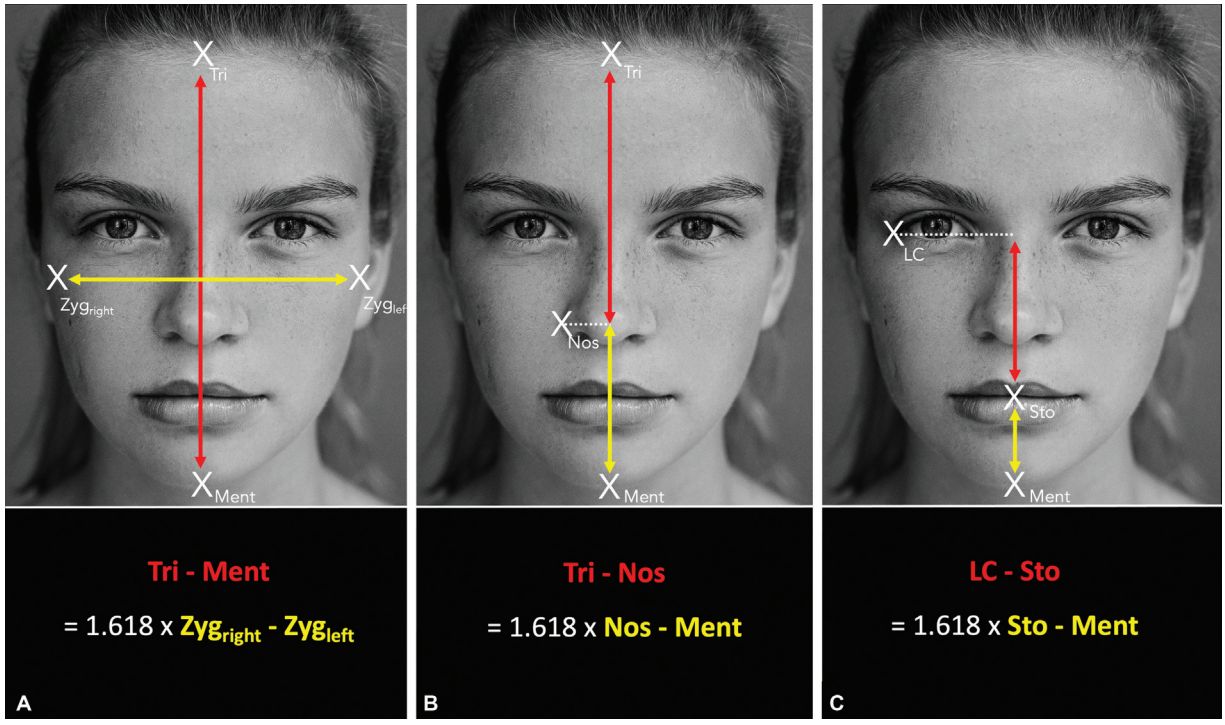

Fig. 3 (**A–C**) Photographs showing the relationship of the golden ratio (i.e., 1:1.618) of different facial measurements.

right zygoma and left zygoma). By utilizing this index, the predominant architecture of the face—also termed facial biotypes—can be determined. The "normal" range for this index was described to be 83.40 to 93.60 and 81.50 to 90.86 for males and females, respectively. Higher values are seen in narrower faces, while lower values are seen in wider faces.[40] In Caucasian males and females, the average facial index was measured to be 88.5 and 86.2%, respectively.[40–42] The facial biotypes and their corresponding prosopic index are summarized in ►**Table 2**.

The *mandible-facial index* is defined as the ratio between facial width (i.e., distance between *right zygion* and *left zygion*) and mandibular width (i.e., distance between *right gonion* and *left gonion*). This index enables the assessor to analyze the shape of the lower two-thirds of the face (e.g., square or conical shape).[40] The "normal" range for this index

Table 2 Categorization of facial biotypes according to the facial index

Facial biotype	Prosopic index	Denomination
Hypereuryprosopic ("very broad face")	<79.9	
Euryprosopic ("broad face")	80–84.9	Braquifacial
Mesoprosopic ("round face")	85–89.9	Mesofacial
Leptoprosopic ("long face")	90–94.9	Dolicofacial
Hyperleptoprosopic ("very long face")	> 95	

was described to be 67.00 to 74.60 and 65.90 to 74.30 for males and females, respectively. Higher values are seen in wider mandibles, while lower values are seen in narrower mandibles (►**Fig. 4**).

Facial Angles and Profile Analysis

The convexity of the face plays an important role in its aesthetic perception. By treating the surface projection of a specific certain facial regions (e.g., in lip volumization), the overall facial appearance is also modified. The convexity of the face can be analyzed with help of two angles.

The *facial convexity angle excluding the nose*, also called *facial contour angle*, spans between the following three points: glabella cranially, subnasale in the middle, and pogonion caudally.[43,44] This angle allows one to analyze the face without the anterior projection of the nasal tip and can be used effectively for the planning of midfacial procedures (e.g., cheekbone augmentation, midface volumization).

The *total facial convexity angle* also includes the projection of the nose and spans between the following three points: glabella cranially, pronasale in the middle, and pogonion caudally.[43–45] This angle allows one to analyze the entire face including the anterior projection of the nose and can be useful for the planning of rhinoplasty procedures (►**Fig. 5**).

In a Caucasian study sample, both angles were reported to be greater in pleasant profiles with 169.20 ± 3.88 degrees for the facial contour angle and 142.67 ± 4.72 degrees for the total facial convexity angle compared with unpleasant profiles with 139.10 ± 4.95 degrees and 165.17 ± 5.81 degrees, respectively.[46]

Orthodontic Measurements

Dental occlusion plays an essential role in the perception of facial aesthetics.[33,34] Angle classified malocclusion as the misalignment or incorrect relation between teeth into three main categories: Class I, Class II, and Class III. For this, the relationship between the mesiobuccal cusp of the maxillary first molar and the buccal groove of the mandibular first molar as well as the relationship of the maxillary incisors and the mandibular incisors is analyzed.[47,48]

Class I malocclusion (neutro-occlusion) describes a normal molar relationship with an altered line of occlusion between maxilla and mandibula due to individual tooth irregularities. The facial profile is not altered (mesognathic).[47,49]

Class II malocclusion (disto-occlusion, also called "overbite") is defined as the mesiobuccal cusp of the maxillary first molar being positioned anterior to the buccal groove of the mandibular first molar. The line of occlusion is altered with space needs, either due to a too small mandible or a too big maxilla. The resulting facial profile is convex with a weak chin (retrognathic).[47,50,51]

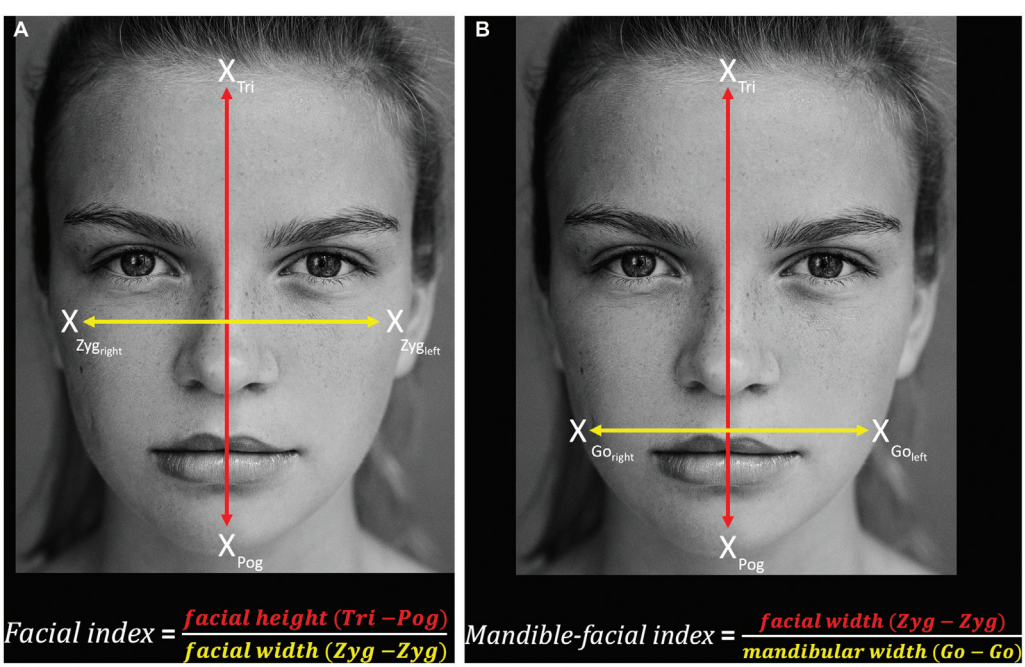

Fig. 4 (**A**, **B**) Photographs showing the facial index and the mandible-facial index as two main indices to assess the overall appearance and shape of the face.

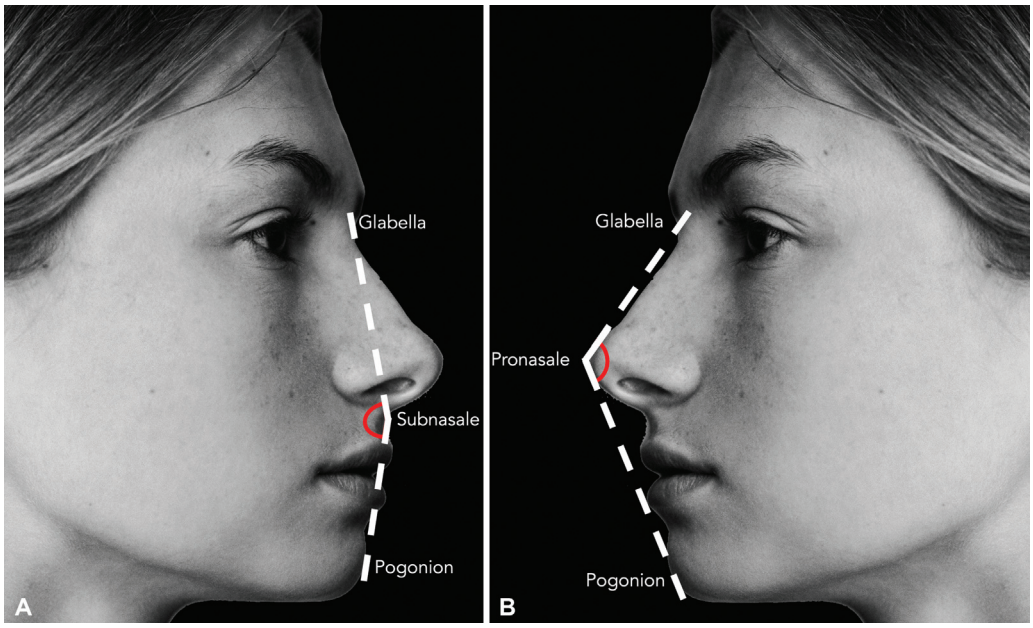

Fig. 5 (**A, B**) Photographs showing the facial contour angle (left) spanning between glabella, subnasale, and pogonion and the total facial convexity angle (right) between glabella, pronasale, and pogonion.

Class III malocclusion (mesio-occlusion, also called "underbite") is defined as the mesiobuccal cusp of the maxillary first molar being positioned posterior to the buccal groove of the mandibular first molar. The line of occlusion is altered with space needs, either due to a too big mandible or a too small maxilla. The resulting facial profile is concave with a prominent mandible (prognathic).[47,52]

Anthropometrics of Specific Facial Regions

Periorbital Region

The relative position of the eyelids and the eyes can effectively be assessed with the measurement of the *margin reflex distance* (MRD). In order to determine it, a light source is held in front of the patient's face and the distance between the light reflection in the pupil and the margin of the upper/lower eyelid (for MRD-1 and MRD-2, respectively) is measured. Normal MRD-1 values are 4 to 5 mm and normal MRD-2 values are around 5 mm.[53] This measurement is useful for oculoplastic surgeons assessing levator function in patients with ptosis. Nonetheless, it should be noted that multiple etiologies can result in lid ptosis. Therefore, thorough evaluation of the underlying cause needs to be performed in order to provide targeted and effective surgical treatment.[54–56] MRD-1 enables the physician to classify the degree of upper eyelid ptosis, while MRD-2 is useful for the classification of the degree of lower eyelid retraction.[57] In patients with unilateral ptosis, the difference in MRD-1 between both eyes allows one to classify the ptosis as mild with $<$2 mm, moderate with 3 mm, and severe with $>$4 mm.[53]

The *interpupillary distance* is defined as the distance between the two pupils in primary gaze position (i.e., when looking straight ahead). This measurement varies strongly between genders and ethnic groups. Interestingly, women with interpupillary distances above average were reported to be rated more attractive.[58]

The *outer canthal* and *inner canthal distances* are defined as distances between the left and right lateral canthus and the left and right medial canthus, respectively.[59] When related to the midline, these distance measurements allow analysis of the symmetry of the eyes (►**Fig. 6**).

The *canthal index* is defined as the ratio between inner canthal distance (i.e., distance between medial canthi) and outer canthal distance (i.e., distance between lateral canthi) multiplied by factor 100. This index enables the physician to objectively assess the (peri-) orbital region and can furthermore help in the diagnosis of syndromic and nonsyndromic craniofacial anomalies in children.[60]

The *horizontal palpebral aperture* is measured as the distance between the medial and lateral canthus of the eye. This distance is dependent on ethnic variations but has been measured to be on average around 30 mm.[59,61] Due to bone resorption in this facial area, this distance has been described to decrease from the age of 45 years onward.[62] The *vertical palpebral aperture* is measured as the distance between the margins of the lower and the upper eyelid in normal gaze position in the midpupillary line and has been measured to be on average around 10 mm while being larger in women compared to men in a Turkish study population.[63] For this measurement, it is important to keep in mind that the upper lid typically exceeds the cranial aspect of the limbus by around 1 to 2 mm, while the lower lid touches the lower limbus in the midline of the eye[53] (►**Fig. 7**).

The relative position of the lateral canthus and the medial canthus is expressed as the *palpebral slant*. This connection is usually directed upward laterally since the lateral canthus is located approximately 1.5 to 2 mm cranial to the medial canthus, with ethnical variations.[64,65] Further, an angle

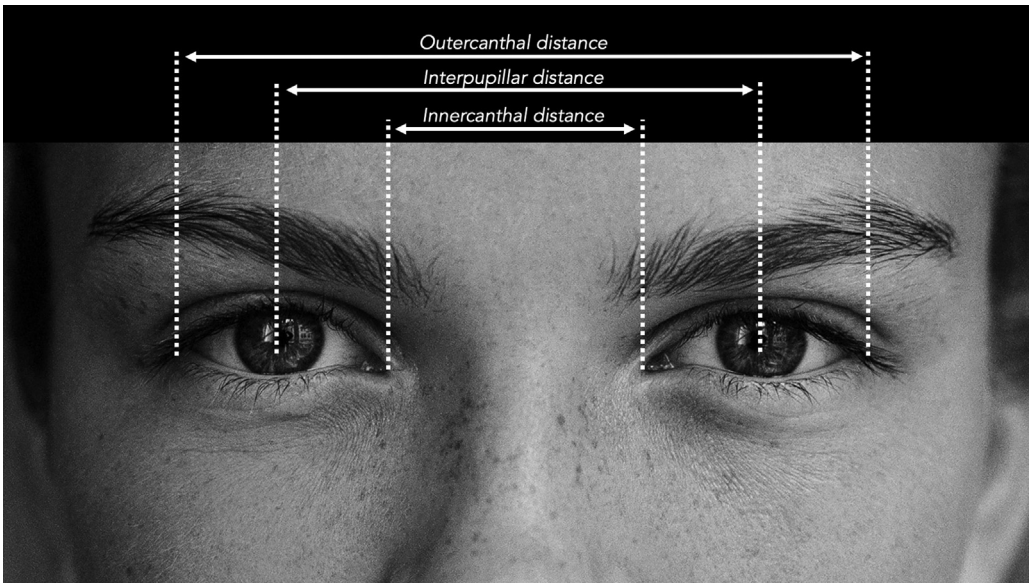

Fig. 6 Photograph showing three important periorbital measurements: the inner canthal distance between bilateral medial canthus, the interpupillary distance between bilateral midpupillary lines, and the outer canthal distance between bilateral lateral canthus.

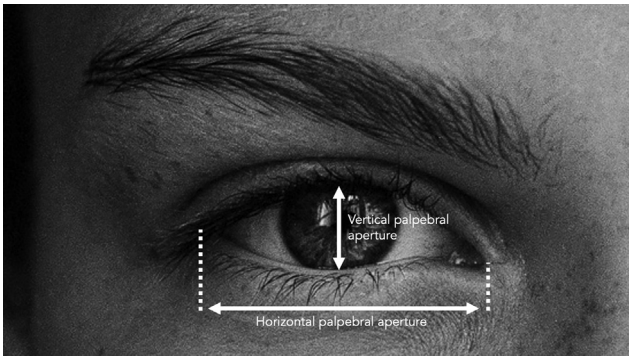

Fig. 7 Photograph showing the measurement of the vertical and horizontal palpebral aperture.

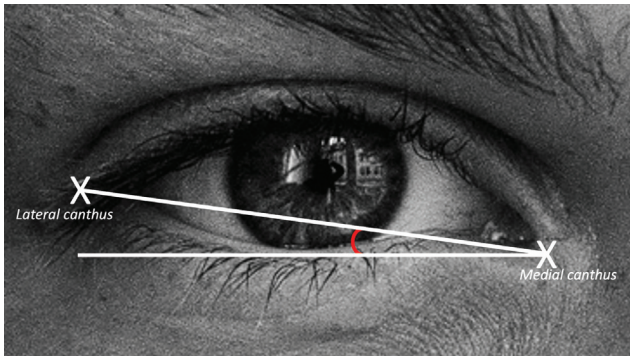

Fig. 8 Photograph showing the palpebral slant angle as an angle between a horizontal line and a line connecting the medial and lateral canthus.

between an imaginary horizontal line and the palpebral slant can be measured as the *palpebral slant angle*. This angle is also helpful in the diagnosis of syndromic and nonsyndromic craniofacial anomalies.[66] Another interesting observation can be made in an aged face: the lateral canthus is observed to descend with increasing age, ultimately leading to a decreased palpebral slant angle[67,68] (►**Fig. 8**).

The *eyelid height* is defined as the distance between the lower margin of the upper eyelid and the eyelid crease (i.e., crease formed between the eyelid skin and the preseptal skin below the eyebrow). This measurement is performed during downgaze to ensure that the eyelid margin and eyelid crease are visible and measurable. Of great interest for physicians treating the periorbital region with soft-tissue fillers is the *upper lid ratio*, which is defined as the ratio between the pretarsal show (i.e., visible distance between the upper eyelid margin and the eyelid crease) and the preseptal show (i.e., visible distance between the eyelid crease and the relaxed brow) in primary position.[69]

While ethnic differences, everchanging trends, botulinum toxin treatments, eyebrow plucking, and aging ptosis make the objective assessment of the eyebrow very difficult, some basic aesthetic principles should be mentioned nonetheless. The eyebrows are typically located on the superior orbital rim in males and are located slightly more cranial in females. In females, the temporal arching is also steeper compared with men. In 1974, Westmore presented the ideal eyebrow as an "arch where the apex terminates above the lateral limbus of the iris, with the lateral and medial ends of the brow at the same horizontal line."[70] It has been reported that increased lateralization of the lash line, the lid crease, and the eyebrow's peak is associated with an attractive periorbital region.[71] Interestingly, it could be observed that the upper eyelid arch's peak is more lateralized with increasing age.[72]

Nose

Although the nose shows great morphological differences between different ethnic groups,[73] basic aesthetic principles and anthropometric measurements of this facial region play an important role for the aesthetic physician.

A vastly important element to be considered in nasal analysis is symmetry since the nose as the central facial element has great influence on an overall symmetrical facial perception. Severe nasal deviation is often associated with facial asymmetries and can possibly mask or demask it.[74] Using the midline of the face, the symmetry of the nasal region can be assessed. Of great interest for the aesthetic physician is the equidistance of the eyes and the medial/lateral canthus at the bony base and the symmetrical appearance of the nasal dorsum in the middle of the nose and the nasal wings as well as the tip at the end of the nose. Looking from caudally, the physician is enabled to assess the symmetry of the columella, the nostrils, the upper ends of the lateral cartilages, the alar wings, and ultimately the projection of the nasal tip.

While the concept of ideal nasal proportions is theoretical and strongly dependent on ethnic preferences, the literature on this topic is worth mentioning. The width of the nasal dorsum should ideally coincide with the width of the philtrum, or with the nasal tip. The dorsal width of men has been reported to be greater compared with women. The width of the bony base of the nose should be approximately 70 to 80% of the nasal width, measured as the distance between both alae.[75–78] The length of the nose allows the physician to objectively measure the sagittal dimension and anterior projection of the patient's nose and is defined as the distance between nasion and pronasale.[79] Initially used for segregationist political purposes as the possibly first ratio ever used in facial anthropometrics, the *nasal index* was later also used in modern medical anthropometry.[80] The nasal index is defined as the ratio between the nasal width at the base (i.e., distance between both alae) and nasal height (i.e., distance between nasion and subnasale) multiplied by factor 100 (►**Fig. 9**).[81] The following classifications can be made according to this ratio: <70 corresponds to the leptorrhine classification with an ethnic prevalence in the Caucasian population, 70 to 85 corresponds to the mesorrhine classification with an ethnic prevalence in the Oriental/Chinese population, and >85 corresponds to the platyrrhine classification with an ethnic prevalence in the African population.[80] Lower values of nasal index correspond to a narrow nose, while higher values correspond to a broader nose. Each of these classifications bring different challenges in surgical and nonsurgical rhinoplasties.[82,83]

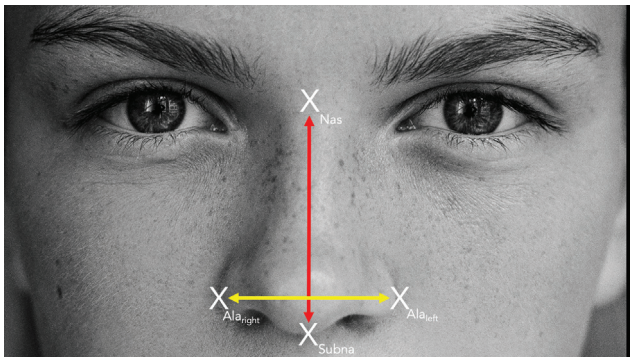

Fig. 9 Photograph showing the measurement of the nasal index as the ratio between nasal width and nasal height.

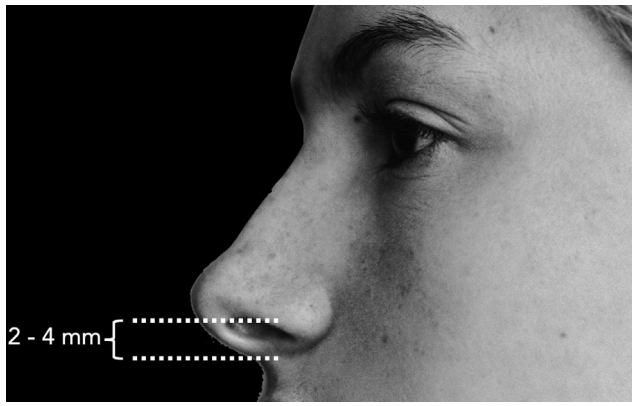

Fig. 10 Photograph showing the "aesthetically ideal" distance of 2 to 4 mm between the columella and the alar margin.

The soft-tissue components of the nose such as the alares and nostrils play an integral role in the nasal width and surface tip projection and ultimately in the aesthetic perception of the nose in general. The morphology, the span, and the profile exposure of the alares with respect to the columella are parameters that define the morphology of the nose.[84] The morphology of the alares strongly influences the morphology of the nostrils, and they mutually define each other. By measuring the angle between both nostril axes with a goniometer, Farkas et al described seven morphological types of nostrils, ranging from smallest angle to greatest angle.[73] When looking from laterally, the columella has been described to be ideally located 2 to 4 mm below the alar margin[85] (►**Fig. 10**).

Ideally, the alar rims were described to form an equilateral triangle when looking at the nostrils from caudally. The ideal tip-to-nostril ratio has been reported to be 1:2. Regarding nasal tip projection, two rules of thumb have been described: either the nasal tip should ideally project 50 to 60% beyond the most anterior point of the superior lip or the nasal tip should project with a length of 0.67 times the nasal length.[86,87]

The *nasofrontal angle* is defined as the intersection of two lines tangent to the glabella and the nasal dorsum at the nasion. It has been reported that the angle perceived as most attractive in male Caucasian profile images is at around 130 degrees.[88]

The *nasolabial angle* is defined as the intersection of two lines connecting the labiale superius with the subnasale and the subnasale with the columella. While the nasolabial angle —like all other facial anthropometric measurements—is strongly dependent on the ethnicity of the patient, the mean value for the most aesthetic nasolabial angle was reported to be 95.96 ± 2.57 degrees for males and 97.7 ± 2.32 degrees for females in a study population with various ethnicities. Ethnical differences are great since Caucasians presented with more obtuse nasolabial angles, while East Africans presented with the more acute nasolabial angles.[89] This angle has also been described to decrease with aging.[90]

The *nasomental angle* is defined as the intersection of two lines connecting the nasion with the pronasale and the nasion with the pogonion. This angle is useful for the

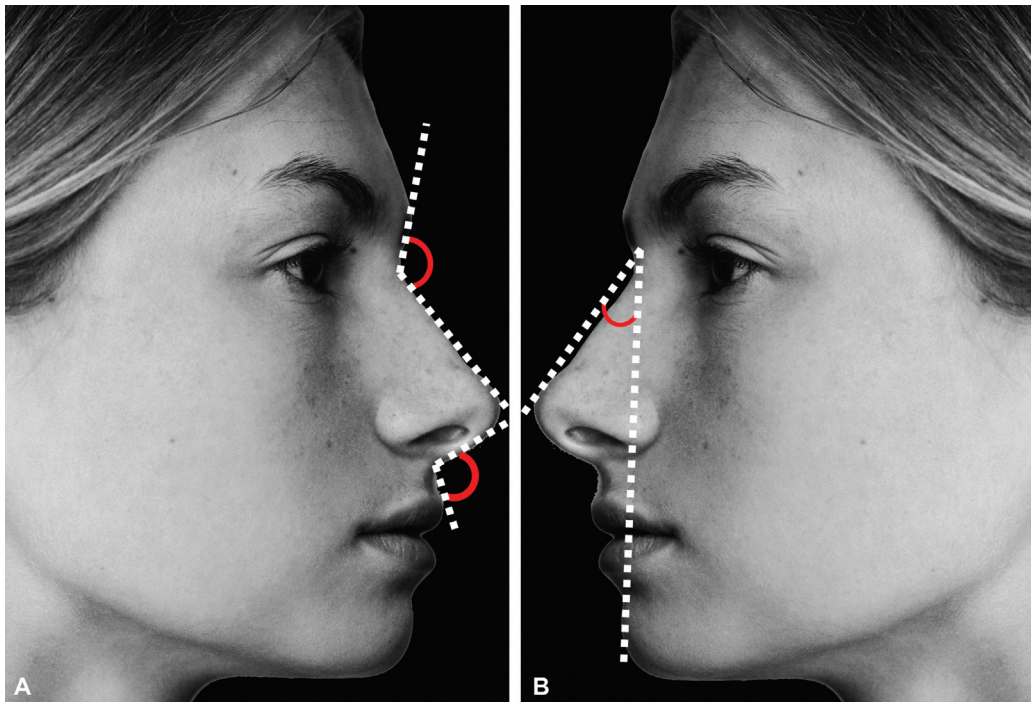

Fig. 11 (**A**, **B**) Photographs showing the nasofrontal angle (left, upper angle), the nasolabial angle (left, lower angle), and the nasomental angle (right).

appraisal of the relationship between nose and chin and is reported to be aesthetically most pleasing within a range of 20 to 30 degrees[43,91] (►**Fig. 11**).

Perioral Region

The *labial index* is defined as the ratio between labial height (i.e., distance between labiale superius and labiale inferius) and labial width (i.e., distance between bilateral cheilions) (►**Fig. 12**).

Based on the *philtrum-labial index*, the labial classification system has been described. This index is defined as the ratio between labial length and philtrum height.[92] According to this classification system, an index of <3 is considered normal.

Various models of ideal proportions and forms of the lips have been described in previous literature.[93,94]

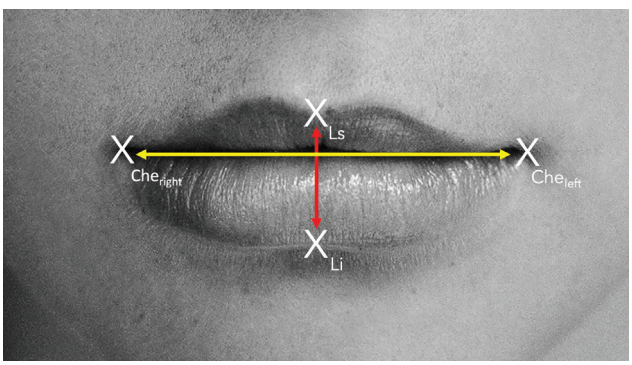

Fig. 12 Photograph showing the labial index as the ratio between labial height and labial width.

The *Steiner's line* (also called S1 line) connects the pogonion and the middle of the "S-curve," which is being formed by the convexity of the nasal tip and the concavity of the upper lip resembling an "S" shape when viewing from lateral. Lips that have their anterior projection on this imaginary line are considered to be aesthetically pleasing.[95,96]

The *Rickett's line* (also called E line from esthetics line) connects the two anthropometric landmarks of pogonion and pronasale. According to the author, the ideal anterior projection of the upper lip should be 4 mm behind this line, while the lower lip should be located 2 mm behind this line.[97]

Like the *Rickett's line*, the *Riedel plane* is defined as a plane tangent to the anterior projection of both lips and allows the aesthetic physician to evaluate the relationship between the anterior projection of the lips and the chin. According to this plane, the anterior projection of the pogonion should ideally be located in this plane.[98]

The *Burstone's line* (also called B line) connects the subnasale and the pogonion. Ideal lip proportions are achieved when the anterior projection of the upper lip in relation to the lower lip is 1.6:1 ("golden ratio"). Unaesthetic results are produced when the anterior projection of the upper lip is in the ratio >1.8:1 when related to the lower lip[99,100] (►**Fig. 13**).

The *Sushner's line* is reported to show the greatest stability and consistency in profile lip analysis and should therefore be considered the line of choice. This line connssects the nasion with the pogonion and allows one to perform distance measurements between this line and the anterior projection of the upper/lower lip.[101,102]

The *Merrifield "Z" angle* allows evaluation of the proportions of the lower face and is taken between a line connecting

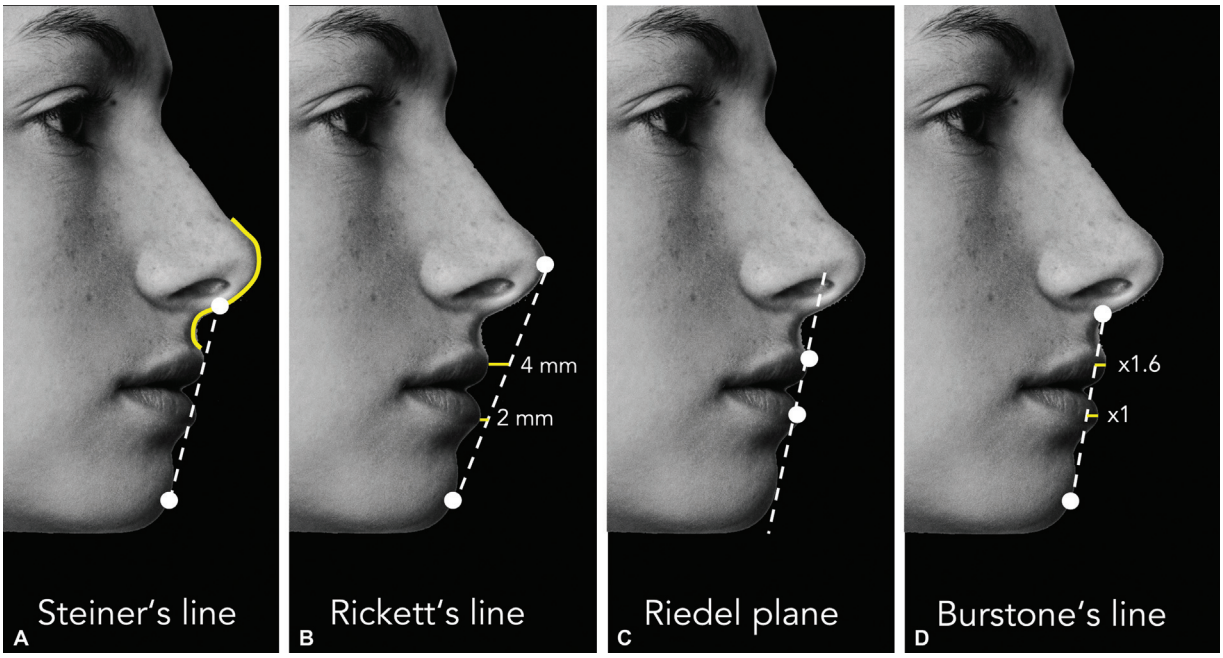

Fig. 13 (**A–D**) Photographs showing four important anthropometric measurements and principles for the assessment of the lower face and lips: Steiner's line, Rickett's line, Riedel plane, and Burstone's line.

pogonion and the most anteriorly projected lip and the Frankfurt horizontal plane. It has been reported that this angle is on average 82.2 degrees for males and 80.2 degrees for females. This angle is important for both the planning of orthodontic and aesthetic treatments of the lower face of great relevance.[103]

The *harmony line* (also termed "H-line") was described by Holdaway and is defined as a line that extends from the pogonion to the most anteriorly projected part of the upper lip (i.e., labium superius). The "H angle" is now defined between the nasion-pogonion line and the H-line. This angle gives an idea of the mandibulomaxillary projection. A normal H angle is about 10 degrees, while larger angles are related to increased facial convexity, which among other reasons can be caused by maxillary protrusion[93,104] (►**Fig. 14**).

Discussion

Anthropometric measurements have a long history, and although they were unfortunately used for political

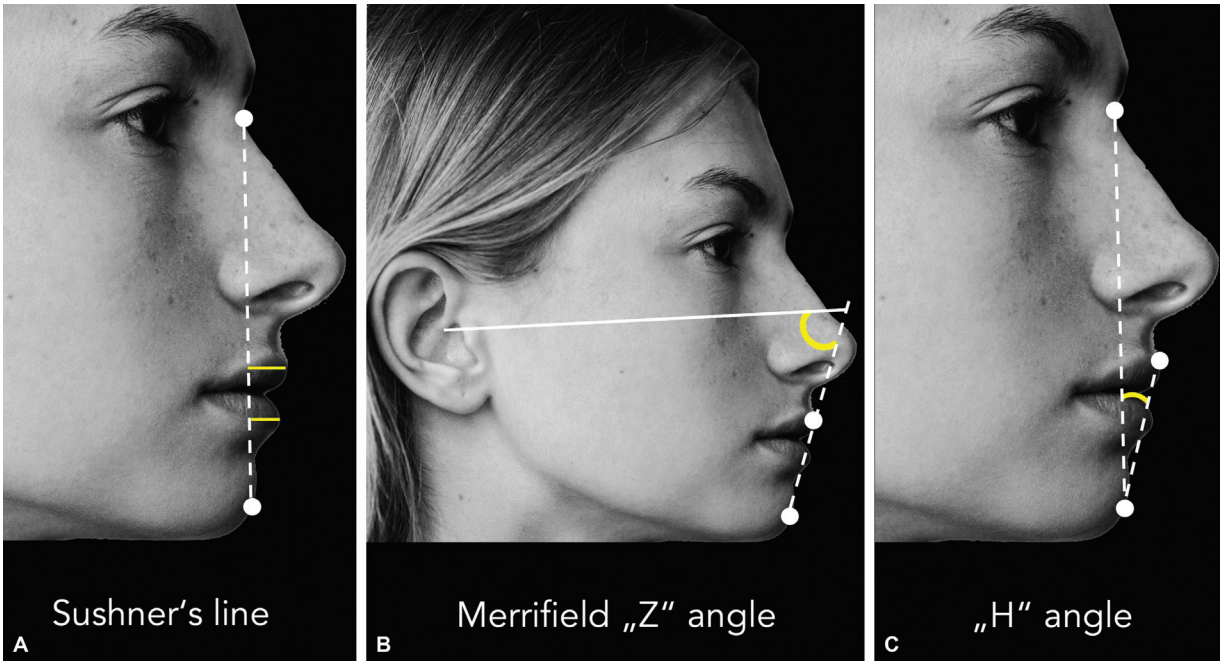

Fig. 14 (**A–C**) Photographs showing three important anthropometric measurements and principles for the assessment of the lower face and lips: Sushner's line, Merrifield "Z" angle, and "H" angle.

segregation, a deeper understanding of how facial surface anatomy can objectively be evaluated with angles, lengths, and proportions can—along with the knowledge of basic aesthetic principles—serve as useful aids for the treating physician. The relevance of facial anthropometrics is shown in recent literature proposing new ideas and concepts on facial beauty to this very day. For instance, Young has presented a new theory on beauty called "circles of prominence" in which he proposes that the ideal of many distances are "dictated by the width of the iris," such as eyebrow height, nasal bridge width, nasal tip width, lower lip height, and many more.[105] Another recent concept based on facial anthropometrical measurements has been published by Goodman. Since the oval face shape has always been perceived as attractive, the author analyzed the "perfect oval shape" based on the photographs of 21 attractive faces of female actors, performers, and pageant winners. The average oval was reported to be constructed from an average of 4.3 times of the intercanthal distance, while the vertical dimension equaled 6.3 times the intercanthal distance.[106] This shows that the ability to objectively analyze facial surface anatomy can be of great use in understanding facial aesthetics and in standardizing facial aesthetic treatments in times of growing demand. A myriad of different concepts and principles to analyze and categorize individual facial anatomy have been described in recent literature. This overview article focused on the most important concepts that can easily be implemented in daily clinical practice, based on the clinical experience and knowledge of the authors. As a limiting factor to the applicability of the measurements and principles presented in this article, it should be noted that the majority was obtained in a Caucasian rather than a multiethnic study population.

Although "ideal" aesthetic proportions have been described numerous times, the perception of aesthetics remains subjective and is highly dependent on the ethnic and cultural background. These ethnic and cultural differences in the aesthetic perception of facial features and proportions have been highlighted in previous studies.[107–109] Multiculturalism and globalization have made us aware that an attractive or beautiful face does not mean having ideal proportions in each facial region.

Therefore, anthropometric measurements can serve as a tool that enables objective analysis of facial surface anatomy but will always need to be combined with the subjective appraisal and most importantly the patient's needs and desires. It requires not only knowledge and analytical skills, but also an artistic sense since the success of an aesthetic treatment can never be guaranteed if the treating physician is simply adhering to previously reported concepts and principles of "ideal proportions," regardless of the individual patient's face. Thus, as Tambone et al pointed out, beauty is an emerging reality composed of objectivity and subjectivity, and we, as professionals in the fields of aesthetic medicine, should not reduce ourselves to the subjective dimension, nor to the purely objective and perfectionist aspect of art and harmony. The practitioner should formulate treatments based on an objective diagnosis and proceed with evidence-based treatment.[110,111]

Today's trend of implementing objective measurements such as three-dimensional surface scans into the planning of aesthetic treatments will play an increasingly important role in the future and will—especially in combination with the emerging artificial intelligence—allow to treat the patient according to his/her preferences and desires and ultimately in a more holistic way.

Conclusion

A multitude of different concepts and principles in the field of anthropometric measurements of facial surface anatomy have been described. By implementing certain anthropometric principles, physicians in the field of aesthetic medicine can improve their treatments and aesthetic results based on objective measurements. Nonetheless, facial aesthetics is not only defined by ideal proportions and shapes but rather by subjective appraisal, which also needs to be taken into consideration when treating patients.

Conflict of Interest
None declared.

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