Anthropometric Parameters for Nose Evaluation and Nasal Surgery Planning

Pasquale Piombino, MD, PhD, Pamela Zace, MD,† Maria Gabriella Grassia, PhD,‡ Rosanna Cataldo, PhD,‡ Marina Marino, PhD,‡ Giacomo De Riu, MD, FEBOMFS,§ Domenico Testa, MD, PhD,‖ Paola Bonavolontà MD, PhD,* and Luigi Califano, MD†*

Background: The esthetic characteristics of face and nose are commonly evaluated before rhinoplasty using a completely subjective method, due to the lack of validated and reliable methods for quantifying facial esthetics and for accurate nose treatment planning. The aim of the study was to review the literature to determine and evaluate the points, distances, and angles commonly used in the treatment planning for rhinoplasty.

Methods: Research based on anthropometric studies of the face and nose, published from 1987 to 2018 was included. Finally, 138 papers were selected after a statistical analysis through a simple random and non-random sample selection, and all papers were evaluated in their entirety.

Results: According to the frequency of citation, 198 points, 336 distances, and 199 angles were listed. The first quartile of each distribution was eliminated, and frequency of more than 25% was selected. A group of 49 points, 77 distances, and 11 angles, were classified according to their anatomical region, that is, bone and soft tissues, was obtained.

Conclusions: An enormous inhomogeneity and lack of standardized anthropometric measurement system, specifically of the nose, was evident, as the studies were conducted by authors of different origins. According to universally accepted parameters, the importance of a reliable method for nose surgery planning is highlighted.

Key Words: Cephalometry, facial analysis, facial attractiveness, nasal anthropometry, nose surgery, rhinoplasty

(*J Craniofac Surg* 2020;31: 1620–1624)

From the *Department of Maxillofacial Surgery, Federico II University of Naples, Naples, Italy; †St Helens and Knowsley NHS Trust, Merseyside, UK; ‡Department of Social Science; §Maxillofacial Surgery Unit, University of Sassari Hospital, Sassari; and ‖Department of Otorhinolaryngology, Luigi Vanvitelli University of Naples, Naples, Italy.

Received June 17, 2019.

Accepted for publication March 10, 2020.

Address correspondence and reprint requests to Pasquale Piombino, MD, PhD, Department of Maxillofacial Surgery, Federico II University of Naples, Via Pansini, 5–80131–Naples, Italy;
E-mail: piombino@unina.it

The authors report no conflicts of interest.

Supplemental digital contents are available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jcraniofacialsurgery.com).

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000006543

Facial beauty comprises attractiveness and social acceptance, and it is assessed by comparing facial features with normal optical values and analyzing their proportions and not the deviation from accepted norm of a single subunit.[1] Potential candidates for rhinoplasty may have varying reasons that influence their decision for undergoing the surgery. Considering patients' complaints that vary from functional limitations to compromised esthetics and alteration of facial balance, it is obvious that objective and final results of rhinoplasty should be considered before planning the surgery. A harmony between all the facial structures should be ensured, particularly with the nose, which forms the middle part of the face, accompanied by consideration of the racial background of the subject. The surgeon should correctly diagnose the case and determine an appropriate treatment plan to achieve this objective (esthetic and facial balance).

Orthodontists have always worked with cephalometric measurements to evaluate dental occlusion and facial esthetics. Correction of malocclusion and facial deformities is planned based on the norms of certain parameters acting as guidelines.[1] Treatment planning for orthognathic surgeries requires analysis of not only the dentition but also the soft tissues and the morphology of the face.[2]

The surgeon performing rhinoplasty should know the essential information pertaining to the nose, especially when nasal cosmesis and function have to be restored, starting with a compromised baseline.[3] Lines, shadows, and highlights of the face combined with different nasal subunits determine nasal attractiveness.[4] Surgical planning is based on the condition of the underlying bone structures and superficial soft tissues, so that the etiology can be identified and an appropriate treatment plan can be elaborated.[4]

The achievement of standardized norms of ideal esthetics can lead to a harmonious and an esthetically pleasing nose. Unfortunately, in rhinoplasty, esthetic characteristics of the face and nose are commonly determined using a completely subjective method and only in a few cases, surgeons perform an objective evaluation based on anthropometric proportional analysis. Frequently, the patient's esthetic outcome is determined by the surgeon using a subjective evaluation and correction.[5]

However, surgeons can perform an objective evaluation of the nasal subunits using anthropometric measurements for surgical treatment planning.[6] This is often rendered difficult due to the lack of validated and reliable methods for quantifying facial esthetics and for accurate nose treatment planning, as observed in the literature.[5]

Nevertheless, knowledge of the commonly used points, distances, and angles used for esthetic facial evaluation and for rhinoplasty is essential, since consistent and predictable guidelines regarding the adoption of facial parameters are not available.

The aim of this study was to review the literature to determine and evaluate the points, distances, and angles commonly used in the treatment planning for rhinoplasty.

MATERIAL AND METHODS

Study Design

In this literature review, the facial landmarks, distances, and angles formed have been summarized.

Search Strategy

A descriptive strategy was determined to be optimal for this study. The research objects were scientific papers (articles, books, or chapters from books) published from 1 January 1987 to 30 April 2018 that documented anthropometric studies of the face and nose.

Two different strategies were adapted for articles and books/chapters from books: the simple random sampling method for articles and the non-random sampling method for books/chapters and other articles.

The articles were searched from the online database of the US Library of Medicine (PubMed). As PubMed includes literature from a large variety of sources, it was used in the present research. The Medical Subject Headings (MeSH) keywords used were nasal anthropometry, cephalometry, facial analysis, facial beauty/attractiveness, rhinoplasty, nose surgery. For the literature search, keywords were paired sequentially with the keyword Nasal Anthropometry (''nasal anthropometry AND cephalometry'' OR ''nasal anthropometry AND facial analysis'' OR ''nasal anthropometry AND facial beauty/attractiveness'' OR ''nasal anthropometry AND rhinoplasty'' OR ''nasal anthropometry AND nose surgery''). From the 2,117 articles found on PubMed, 75 articles were selected at random (simple random sampling). A non-random selection of articles was conducted by 2 authors (PP and LC), adding 75 references to the review. Books or chapters from books present in the references of the PubMed articles, but not present in the database, were included using a non-random selection.

Inclusion and Exclusion Criteria

The PubMed search results were screened, and duplicate articles were eliminated. Correspondence letters, How-I-do-It types of articles, and articles published without an abstract were excluded. Only the English-language literature pertaining to humans or studies conducted on humans and published in the English-language with a complete access were considered. Articles not included in the initial search results but cited in the included articles were studied for content to determine the missing papers by literature retrieval.

Books or single chapters present in the references of the included PubMed articles and with MeSH keyword/s in the title were included.

Sample

Of the 150 selected papers, 12 were further excluded, either due to presence of an irrelevant subject or due to the absence of essential information required for the study. Finally, 138 papers met the inclusion criteria and are presented in this review. Figure 1 illustrates the sampling strategy.

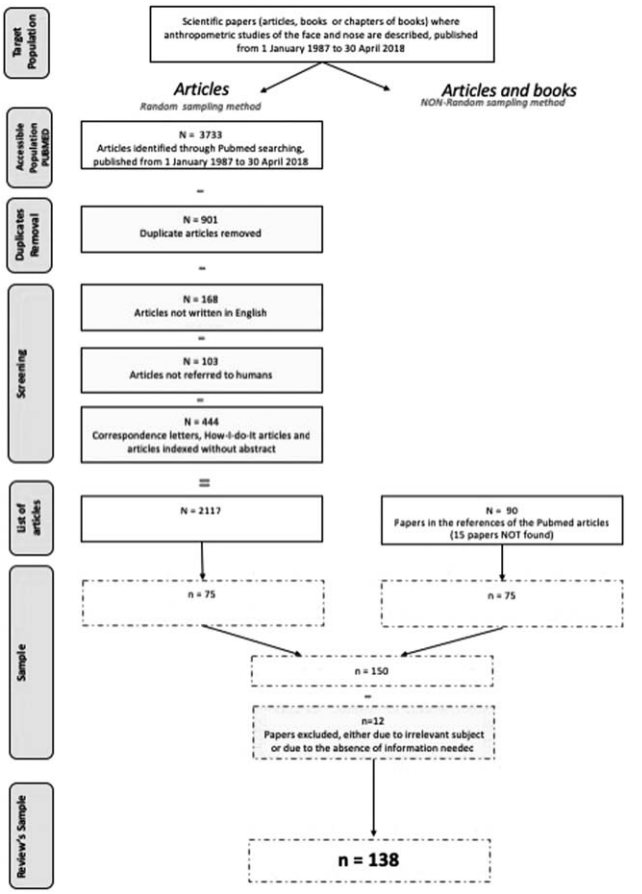


FIGURE 1. Flow chart illustrating the systematic literature research according to PRISMA statement.

RESULTS

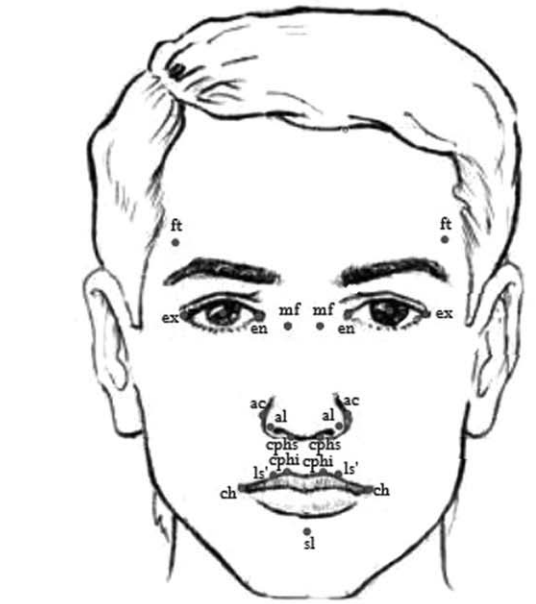
The articles were categorized, according to the analyzed anatomical region, into soft tissue and bone tissue. The linear distances and angles studied in the papers were also reviewed. A total of 198 points, 336 distances, and 199 angles were listed according to their frequency of citation by different authors. After independent evaluation by 2 authors (DT and PZ), anthropometric bone and soft tissue landmarks matching the same actual physical points in bone and soft tissues were identified. One-to-one matching of those anthropometric landmarks was conducted, with the most-cited consisting the nomenclature as illustrated in Supplementary Digital Content, Table 1, http://links.lww.com/SCS/B401. This matching was extended to linear and angular measurements. Landmarks referring to points not relevant to this study were eliminated from the analysis.

A statistical analysis of the collected data was performed to describe the basic characteristics of data elaborated in the studies. For this statistical analysis, the first quartile of each distribution was eliminated, and a frequency of more than 25% was selected. A group of 49 points, 77 distances, and 11 angles was obtained (Supplementary Digital Content, Table 2, http://links.lww.com/SCS/B401, Figs. 2–5). All results were categorized according to their anatomical region, that is, bone (13 points) and soft tissues (36 points).

DISCUSSION

The nose is an essential unit that influences the facial appearance considerably.[7] It is an osteochondral structure covered by a perichondroperiosteal envelope, consisting of muscles and cutaneous tissues. The knowledge of nasal anatomy is vital for an accurate preoperative analysis and subsequently, for determining the surgical technique most appropriate for the patient. A standardized analytical method that considers the anomalies, proportion, and harmony of the nose, during rhinoplasty, will help in evaluating the complications associated with a specific treatment.

In 1986, Farkas stated the importance of nasal measurements using facial anthropometry and highlighted the importance of ethnic



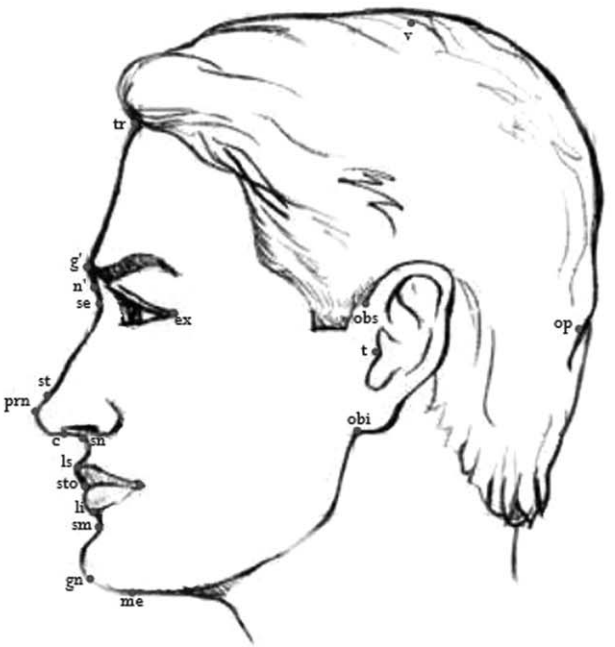


FIGURE 2. Landmarks on frontal and profile view on soft tissue.

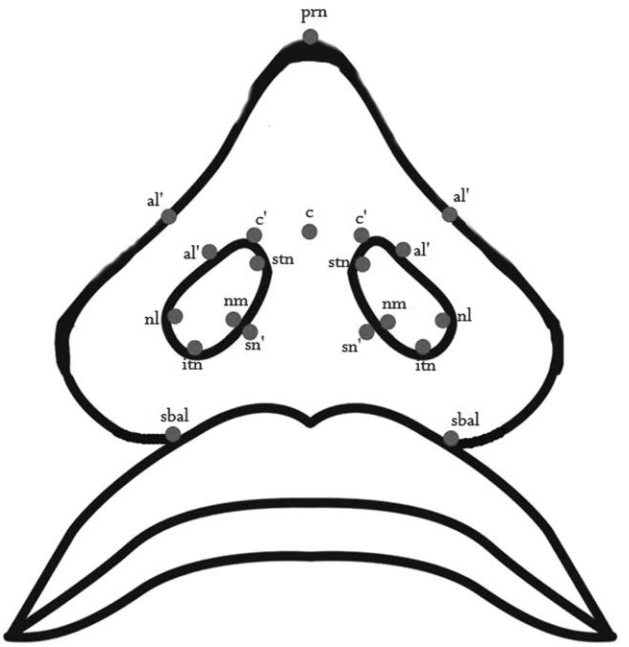


FIGURE 3. Soft tissue landmarks on submental view.

group differences. He concluded that most differences between ethnic groups are observed in nasal proportions.[8] He evaluated facial beauty considering 29 indexes and stated that a deviation of more than 1 standard deviation from the normal value is indicative of a disharmonious face. Subsequently, other authors, primarily rhinoplasty surgeons, presented their own methods, based on personal experiences, for the evaluation of nose and described the landmarks and measurements that are considered parameters of ideal facial beauty and harmony. In many papers, the patients' anthropometries were compared to a mixture of ideas defining beauty and modern features of models and celebrities of the period.[9] This lack of uniformity of views is evident in routine clinical practice, where the patient is intuitively analyzed by the surgeon. The specialist decides if a specific condition is within the range of normalcy and beauty and subsequently adopts surgical techniques that rely on his/her knowledge and experience.[10]

The analysis of this systematic review showed that no standardized, accepted, and widely adopted method exists for the preoperative evaluation and accurate planning of nose surgeries, as is evident in the field of orthodontics. The literature was searched for papers published during the past 32 years, from 1987 to 2018, using pairs of keywords specifically utilized for searching the database for articles on nose surgery. After considering the exclusion criteria, 2117 articles were included. MeSH terms obtained from different medical fields were searched in pairs as searching for single keywords resulted in enormous articles that were difficult to evaluate. The online database PubMed was selected because of the inclusion of large variety of sources compared to that in other medical databases. A similar review was conducted by Doddi in 2010 that considered 3292 results published between 1973 and 2009 using MeSH terms such as nasal/nose, anthropometry/history/methods/measurements, esthetics, surgery, nose, and otorhinolaryngologic surgical procedures.

The articles included in the study underwent random sample selection, and additional articles obtained from the references of articles included in the study as well as books and chapters from books had a significant impact in our study. After screening, 138 papers were included (Fig. 1).

Facial landmarks, linear distances, and angular measurements classified by authors were searched and a list of 198 points, 336 distances, and 199 angles was obtained. After a "personal" analysis conducted by 2 authors (DT and PZ), a significant number of landmarks were identified to be same even if different names were described by the authors (Supplementary Digital Content, Table 1, http://links.lww.com/SCS/B401). The subnasale (sn) and the columella base were found to be matched; however, columella base is only seen in the submental view, while subnasale was seen in the frontal and the profile view. This matching was also extended to measurements, where they are used. Porion, superior and inferior palpebral fissures, postaurale, preaurale, superaurale, and subaurale

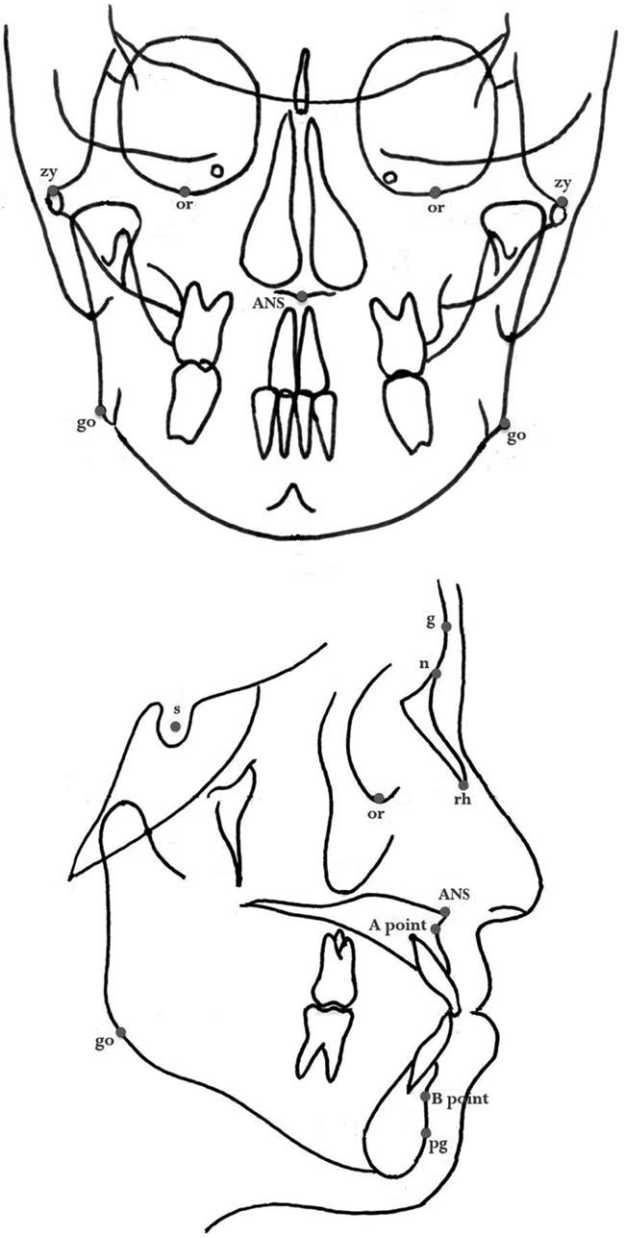


FIGURE 4. Soft and bone tissue landmarks on profile view.

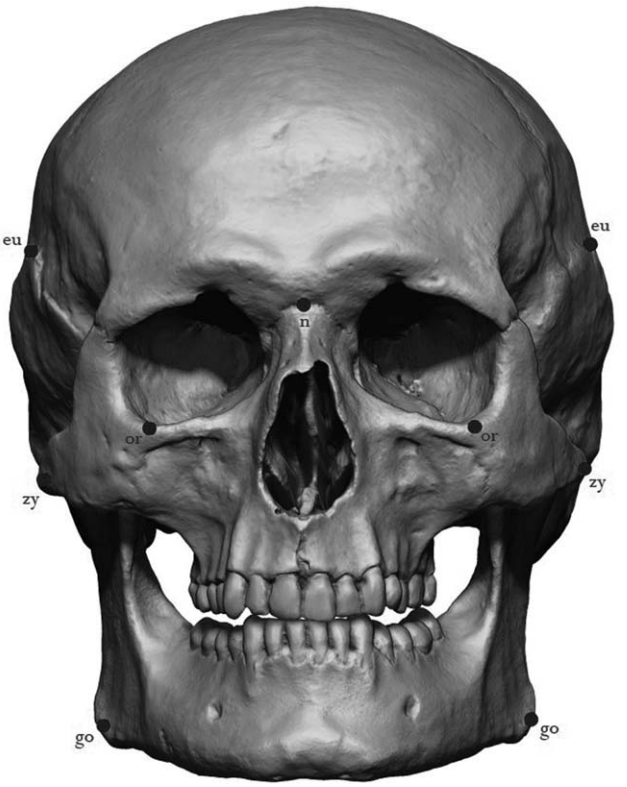


FIGURE 5. Bone tissue landmarks on frontal view.

were removed from the analysis, since they and their linear and angular measurements were not directly related to the nose pyramid.

A controversy associated with this review was the authors' disconcordance on some points, specially referring to soft or hard tissues. This was noted in the following points: *Glabella* (g): according to Swennen et al, it is the anterior-most point of the frontal bone, while according to Farkas et al, it is a cephalic surface point at the most prominent point on the midline between the eyebrows.[7,11] In this study, it was considered as a bone landmark and its projection was the soft tissue *Nasion* (n): according to Farkas et al, it is defined as the bony profile landmark located in the midline of the nasofrontal suture, while Szychta et al referred it as the most concave part of the upper pole of the nasal bridge. Nagasao et al defined it as the bottom of the concavity at the nasal root, implying a bony landmark.[7,12,13] This discrepancy extended to both distances and angles, since authors confused the exact point. Hence, the same distances or angles were actually given different names. In our study, we found that nasion was considered a bony landmark by Farkas et al and Swennen et al, while sellion (se) was considered a soft-tissue landmark (The deepest point of the nasofrontal angle).[7,11]

Considering this variance, the *nasion* and *sellion* were matched in the nasofrontal angle as well as in the *nasal tip* angle, since authors were actually referring to the same landmark. In contrast, this matching was not possible for distances as they differ between the hard- and soft-tissue landmarks.

Regarding the angles considered in our study, a noticeable dissension was evident among the authors about the measurements of various angles, since they did not represent the angles using the same points. For instance, the nasolabial angle was defined by some authors as the angle formed by pronasale (prn)-sn-labiale superius (ls)[14] and by others as the angle formed by columella (c)-sn-ls.[15] However, all the authors demonstrated the same angle.[15] Another controversy was associated with the nasofrontal angle. It was observed that some authors considered the referral point nasal dorsum (not mentioned in the analyzed points due to the absence of statistically significant amount of citations),[16] while others considered pronasale (prn).[17] However, all the authors actually indicated the same angle.[17,18] Similarly, for the nasofacial angle, some authors considered the angle formed by g-nasal dorsum / p-plane,[18] while others considered the angle between *prn-n / g-pogonion (pg) line*.[19,20]

Therefore, our study demonstrated the perplexity of the authors when using facial landmarks, due to the lack of standardized anthropometric system for evaluating the nasal region.

Many authors do not refer the angles with their referral points, but either name it or demonstrate it as a schematic representation.[20,21] Such angles were also considered in the analysis.[21,22]

The techniques used in the analysis studied the samples and the measures in a simple manner. Particularly, a written analysis was conducted that identified the points of potential interest to select the ones most frequently used in the selected articles. As shown in Supplementary Digital Content, Table 2, http://links.lww.com/SCS/B401, the first three points most frequently used by the authors were part of different anatomical regions: "sn/c base" and "Nasal tip/prn" were the soft-tissue landmarks while "n" was a bony landmark.

This study did not attempt to define the characteristics of an ideal nose or the desired nose, but the possibilities to be more effective in achieving a pleasing result from rhinoplasty, by considering the various facial proportions. Rhinoplasty surgeons should understand the average nasal proportions by knowing the frame of reference used while discussing esthetic objectives with patients.[8]

The basis of rhinoplasty is the analysis and appropriate planning considering both esthetic and functional parameters. It was evident through this review that there was no uniformity in the methods of analysis of the nasal pyramids for rhinoplasty. In 2005, Farkas considered only 14 linear anthropometric measurements to evaluate different ethnic groups, 10 of which were already used in the neoclassical canons of the Renaissance by Leonardo Da Vinci and Durer.[8] In this study, 336 linear measurements were found on initial evaluation, and 77 statistically significant measurements considered by authors in the last 32 years were obtained after analysis. The measurements used by Farkas did show in the results of our analysis, but they have been augmented largely by the measurements performed by authors from different origins. This leads to the conclusion that enormous inhomogeneity and lack of standardized anthropometric measurements, specifically of the nose, exists in our literature.

Doddi et al is the most recent review that highlighted the role of nasal measurements for nasal surgery.[10] Various methods of anthropometric evaluation in the literature were described with their merits and demerits. Farkas et al tried to define the normal range of measurements and concluded that many differences between races, specifically in the nose region, were evident. Doddi et al stated that anthropometric landmarks could be helpful in research, cleft surgery, and nasal reconstructive septoplasty, particularly in the pediatric population, as well as in the evaluation of dysmorphic syndromes.[10]

In this review, the study conducted by Doddi et al was followed, using a different approach, since the aim was to understand the parameters that are actually useful in clinical practice, based on a scientific review of literature. It was observed that several healthcare professionals use different approaches for nasal anthropometric measurements with many differences in specific landmarks, linear, and angular measurements. The quality of scientific evidence is low and well-defined studies are required to determine if the identified landmarks do provide benefits for the patients and their surgical procedures. A rhinoplasty sub task force would be the appropriate and correct way to definitely delineate standard measurements in nose surgery.

REFERENCES

1. Reyneke JP, Ferretti C. Clinical assessment of the face. *Sem Orthod* 2012;18:172–186
2. Sarver D, Jacobson RS. The Aesthetic dentofacial analysis. *Clin Plast Surg* 2007;34:369–394
3. Kim DW, Toriumi DM. Nasal analysis for secondary rhinoplasty. *Facial Plast Surg Clin N Am* 2003;11:399–419
4. Cakir B, Oreroglu AR, Daniel RK. Surface aesthetics and analysis. *Clin Plast Surg* 2016;43:1–15
5. Bashour M. An objective system for measuring facial attractiveness. *Plast Reconstr Surg* 2006;118:757–774
6. Abbas OL, Kurkcuoglu A, Pelin C, et al. Anthropometric measurement and analysis of the lower face in Turkish rhinoplasty patients. *Eur J Plast Surg* 2015;38:449–458
7. Farkas LG, Kolar JC, Munro IR. Geography of the nose: a morphometric study. *Aesth Plast Surg* 1986;10:191–223
8. Farkas LG, Katic MJ, Forrest CR, et al. International anthropometric study of facial morphology in various ethnic groups /races. *J Craniofac Surg* 2005;16:615–646
9. Ballin AC, Carvalho B, Dolci JE, et al. Anthropometric study of the Caucasian nose in the city of Curitiba: relevance of population evaluation. *Braz J Otorhinolaryngol* 2017;S1808-8694:30103–30109
10. Doddi NM, Eccles R. The role of anthropometric measurements in nasal surgery and research: a systematic review. *Clin Otolaryngol* 2010;35:277–283
11. Swennen GRJ, Schutyser F, Hausamen J-E. *Three-dimensional Cephalometry.* New York, USA: Springer; 2005
12. Szychta P, Witmanowski H, Rykala J. Assessment of the usefulness of three-dimensional scanner in aesthetic evaluation of post-traumatic rhinoplasty. *J Plast Surg Hand Surg* 2013;47:106–112
13. Nagasao T, Miyamoto J, Hikosaka M, et al. A new method to quantify subtle morphological deformities in nasal profile curvatures and its application for analysis of unilateral cleft lip noses. *J Cranio-Maxillofac Surg* 2008;36:321–334
14. Ozkocak V, Ozdemir F. Age-related changes in the external noses of the Anatolian men. *Aesth Plast Surg* 2018;42:1336–1342
15. Li KZ, Guo S, Sun Q, et al. Anthropometric nasal analysis of Han Chinese young adults. *J Cranio-Maxillo-Facial Surg* 2014;42:153–158
16. Park JH, Mangoba DCS, Mun SJ, et al. Lengthening the short nose in Asians: key maneuvers and surgical results. *JAMA Facial Plast Surg* 2013;15:439–447
17. Kim SH, Whang E, Choi HG, et al. Analysis of the midface, focusing on the nose: an anthropometric study in young Koreans. *J Craniofac Surg* 2010;21:1941–1944
18. Milgrim LM, Lawson W, Cohen AF. Anthropometric analysis of the female Latino nose. *Arch Otorhinolaryngol Head Neck Surg* 1996;122:1079–1086
19. Rho NK, Park JY, Youn CS, et al. Early changes in facial profile following structured filler rhinoplasty: an anthropometric analysis using a 3-dimensional imaging system. *Dermatol Surg* 2017;43:255–263
20. Venkatadri G, Farkas LG, Kooiman J. Multipurpose anthropometric facial anglemeter. *Plast Reconstr Surg* 1992;90:507–510
21. Youn SH, Seo KK. Filler rhinoplasty evaluated by anthropometric analysis. *Dermatol Surg* 2016;42:1071–1081
22. Leong SCL, White PS. A comparison of aesthetic proportions between the healthy Caucasian nose and the aesthetic ideal. *J Plast Reconstr Aesthet Surg* 2006;59:248–252