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Abstract

Objective. To measure the anterior nasal spine length (ANSL) and septal caudal extension (SCE), as well as assess the strength of association between these variables and tip projection in the Middle Eastern nose. Our secondary aim was to assess if columellar-labial angle (CLA) or columellar-spinal angle (CSA) vary as a function of ANSL and/or SCE.

Study Design/Setting. Prospective single institutional study.

Subjects. Middle Eastern primary rhinoplasty patients without nasal trauma or prior endonasal surgical history.

Methods. Photographic and intraoperative caliper measurements were used to determine Goode ratio (GR), CLA, CSA, ANSL, and SCE. Associations between numeric variables were examined with scatterplots, including use of LOWESS curves and Pearson correlation coefficients. Linear regression models were used for predicting quantitative variables (GR, CLA, CSA). Logistic regression models were used for predicting overprojection status based on GR.

Results. In total, 102 patients met inclusion criteria (82 females, 20 males). Mean ANSL and SCE were 8.6 mm and 14.9 mm, respectively; ANSL and SCE had a strong positive association with each other. SCE and ANSL were found to have low predictability for GR, CLA, or CSA.

Conclusion. Determinations of projection status using the GR method do not appear to be related to ANSL or SCE values in our Middle Eastern study group. Relationships of absolute columellar-labial or columellar-spinal angles are likely more complex than isolated value implications of SCE or ANSL.

Keywords

Middle Eastern nose, nasal spine, Goode ratio, septal length, columellar-labial angle

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anterior nasal spine (ANS) and dorsal and quadrangular cartilage, leading to tip overprojection, blunting of the columellar-labial angle (CLA), and apparent foreshortening of the upper lip. Although the ANS can contribute to the disproportionate relationships of the nasal base in the tension nose, it is felt that the prominence of the posterior septal angle is invariably the main cause of these problems. In a series of 57 consecutive female patients of Northern European descent, Rowe-Jones and van Wyk identified tip overprojection in 54%, tension nose in 30%, and a prominent ANS/posterior septal angle in 26%. Similar to Johnson and Godin, they also felt extrinsic nasal dorsal and tip overprojection related more to overdevelopment of the septal quadrangular cartilage than ANS.

Given the paucity of objective data relating to this area of the Middle Eastern nose, the goal of this study was to assess the strength of association of the values of anterior nasal spine length (ANSL) and septal caudal extension (SCE) with nasal tip projection. Our secondary aim was to determine if CLA and columellar-spinal angle (CSA) vary as a function of these values.

**Materials and Methods**

A prospective study used 102 consecutive Middle Eastern patients who underwent primary external rhinoplasty (± septoplasty) by the primary author between January 2015 and November 2016. The Beaumont Health Institutional Review Board approved the study (2016-241), and verbal informed patient consents were obtained. To meet inclusion criteria, individuals had to be dentate, without prior septonasal fracture injury or history of previous endonasal surgery, and without moustaches that would obscure topographic landmarks. Baseline data pertaining to age, sex, and country of origin were recorded.

Preoperatively, standard 4-view rhinoplasty photographs were acquired with a Canon EOS 30D camera (Canon, Oita, Japan) on full auto mode using a 28- to 135-mm zoom macro lens. All photographs were taken at a fixed distance to a target of 30 inches (0.85m) at an f-stop of 1:5.6 and shutter speed of 1/60 s. Images were stored on a 32-GB SanDisk Compact Flash (CF, Milpitas, California) and subsequently developed onto 6 × 4-inch photo paper using an Epson Picture Mate PM240 printer (Epson, Manila, Philippines) with a resolution of 5760 × 1440 dpi. Using a lateral view, the Goode ratio was determined with direct ruler measurement following defined points of reference, as summarized by Robinson and Thornton. Overprojection was defined as a Goode ratio ≥0.61 and underprojection as a Goode ratio ≤0.54. CLA and CSA were derived by protractor measurement and recorded in degrees (Figure 1). In cases where a CSA did not exist, we defined CSA = CLA. These angles become identical as there is absence of an anterior soft tissue prominence overlying the spine on lateral view, which otherwise creates a blunting of the CLA if measured at the point anterior to this prominence (CSA) or at the base of the columella where it meets a line drawn adjacent to the upper lip line (CLA). When this prominent soft tissue over the spine is present, the CSA is always more obtuse than the CLA. This is demonstrated in Figure 1.

SCE and ANSL were measured intraoperatively in millimeters using a caliper following an open approach exposure of the anterior-most and caudal aspect of the septum and premaxilla. The SCE was measured between the anterior-most point of the pyriform aperture (PA) and the anterior-most point of the caudal septum in a ventral-dorsal plane. The ANSL was measured between the PA and the leading point of the bony spinous prominence in the ventral-dorsal plane following soft tissue removal. Data were compiled by the primary author and stored in an Excel (Microsoft, Redmond, Washington) file following institutional review board security guidelines.

**Statistical Analysis**

Categorical variables were summarized with counts and frequencies. Numeric variables were summarized by mean and standard deviation for normally distributed variables and by median and range otherwise. The associations between numeric variables were examined with scatterplots with LOWESS (LOcally WEighted Scatterplot Smoothing) lines. Pearson’s correlation coefficients summarized the strength of association between numeric variables. Linear regression models were used for the prediction of quantitative variables; logistic regression models were used for the prediction of overprojection status. Both univariate and bivariate regression models were considered; Receiver operating characteristic (ROC) curves were obtained for logistic regression models. We used the SAS System for Windows version 9.3 (SAS Institute, Cary, North Carolina) for statistical analysis and Minitab Release 14 (Minitab, State College, Pennsylvania) for graphs.

**Results**

**Demographics**

Table 1 shows the demographic and clinical characteristics of the 102 Middle Eastern study patients. The group was 80% female with a median age of 23 years (range, 16-46).
Using Goode ratios, 45% of subjects had overprojection, 48% had ratios in the ideal range, and 7% had underprojection. Most (95%) identified their country of origin as Iraq, with very small counts from other countries: Jordan (1), Lebanon (1), Yemen (2), and Palestine (1). The average nasal spine length was 8.6 mm with a wide range (3-15 mm). The anterior-most septal cartilage ledge extended, on average, over 6 mm from the nasal spine point.

### Relationship of SCE and ANSL to Goode Ratio

Scatterplots depicting the relationships of the Goode ratio to SCE and ANSL are shown in Figure 2A, B. While there is a strong positive association between the values of SCE and ANSL, there does not appear to be a strong relationship of either SCE or ANSL with the Goode ratio. Pearson’s correlation coefficients are as follows: ANSL and SCE, 0.74; SCE and Goode ratio, 0.19; and ANSL and Goode ratio, 0.27. The scatterplots with LOWESS smoothers suggest that the relationship between the Goode ratios and these 2 variables is no more complicated than linear; linear regression models predicting the Goode ratio from ANSL and/or SCE explain no more than 7% of the variation in the Goode ratio.

We used logistic regression models to examine whether SCE and/or ANSL help predict whether the Goode ratio is at least 0.61 (overprojected). While SCE ($P = .04$) and ANSL ($P = .02$) each had a statistically significant effect in univariate logistic regression models, neither variable was statistically significant in a bivariate logistic regression model with both ANSL and SCE. However, none of the 3 models provided a good prediction of overprojection as measured by the area under the ROC curve (c-statistics).

### Relationship of SCE and ANSL to CSA and CLA

Using a scatterplot matrix (not shown), neither SCE nor ANSL appears related to CSA. Pearson’s correlation coefficients are 0.04 between SCE and CSA, and 0.19 between ANSL and CSA. Scatterplots with LOWESS smoothers provided little evidence that the relationship between CSA and these 2 variables was more complicated than linear. When linear regression models were fit relating one or both of SCE and ANSL to CSA, less than 3% of the CSA variability was explained by the model, and no effect was statistically significant. Using a scatterplot matrix (not shown), neither SCE nor ANSL appears related to CLA. Pearson’s correlation coefficients are 0.19 between SCE and CLA, and 0.14 between ANSL and CLA. Scatterplots with LOWESS smoothers provided little evidence that the relationship between CLA and these 2 variables was more...
complicated than linear. When linear regression models were fit relating one or both of SCE and ANSL to CLA, less than 3% of the variability in CLA was explained by the model, and no effect was statistically significant.

**Exploration of the Effect of Sex**

Boxplots (not shown) were obtained comparing the values of SCE, ANSL, and the Goode ratio for women and men. The boxplots indicate a tendency for men to have larger values for all 3 of these characteristics than women. In addition, scatterplots were obtained with separate LOWESS smoothers by sex to examine whether the relationship between the Goode ratio and SCE or ANSL was similar for women and men (Figure 4). These plots suggest that for a given level of SCE or ANSL, men tend to have larger values for the Goode ratio than do women; however, these differences do not achieve statistical significance at the .05 level, although they do at the .15 level. On average, the Goode ratio for a man is 0.022 larger than for a woman with the same value of SCE, 0.020 larger than for a woman with the same value of ANSL, and about 0.022 larger than for a woman with the same values for both CSE and ANSL using the 2 univariate and bivariate linear regression models, respectively.

**Discussion**

The ANS is formed from the fusion of the maxillary alveolar processes and is subjected to anterior tractive forces at

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**Figure 2.** Scatterplot of the Goode ratio vs (A) septal caudal extension (SCE) and (B) anterior nasal spine length (ANSL) with LOWESS and regression lines.
the site of insertion of the septo-premaxillary ligament.\(^9\) ANS formation, which is unique in humans among mammals and primates,\(^11\) may be the result of bony resorption on the labial side of the premaxilla and depository fields on the lingual side, resulting in downward growth direction.\(^12\) Anatomically, it is defined by the linear measurement from the lingual side, resulting in downward growth direction.\(^12\) Lang\(^13\) believed the ANS correlated with the shape of the soft tissues of the nose and alveolar position and reported variations in length of 0 to 9 mm in adults and up to 15 mm in cadavers (sex/ethnicity unspecified). Racial differences in ANS morphology and prominence were reported in a study consisting of 190 dried African American and Caucasian skulls, showing a more prominent ANS among Caucasians that was determined by 24 weeks prenatally.\(^18\) In our own study, predominantly consisting of patients of Iraqi descent, ANS values trended toward prominent (mean, 8.6 mm; range, 3-15 mm). To our knowledge, there are no other specific normative data pertaining to ANS length other than cited herein.

The anteroinferior edge of the caudal septum is attached to the ANS (chondro-spinal junction) and is defined as the posterior septal angle. Although quantitative studies correlating septal and ANS length have not yet been reported to our knowledge, observations of the “caudal excess nasal deformity” have been described.\(^15\) This rare profile deformity is attributed to elongation of the caudal septum, overgrowth of the ANS, premaxillary protrusion, or combinations thereof. Considered by some to be a variation of the “tension nose,” it is distinguished in that it may occur independent of dorsal overgrowth. Friedman et al\(^16\) reported a need for ANS reduction in approximately 20% of patients with elongated septums. By contrast, others have found the posterior septal angle to often be overdeveloped in the presence of a normal ANS.\(^8\) Among our study participants, we found a strong positive association between the values of SCE and ANSL (Pearson’s correlation coefficient = 0.74), which frequently required some form of septal shortening at the time of ANS resection.

The nasal spine is considered a minor tip support mechanism, and its overdevelopment imparts an upward thrust of the tip components.\(^17\) Despite claims that hyperplasia of the ANS can be partially or totally responsible for overprojection of the tip,\(^18\) others have observed that its removal alone has little or no effect on nasal tip projection.\(^19\) More often, it is a combination of factors that contributes to overprojection and may include overdevelopment of the alar cartilages, quadrangular cartilage, ANS, or any combination of these.

The Middle Eastern nose shares many features of the caudal excess nasal deformity and the tension nose, including a long nose, ptotic tip, acute columellar-labial angle, and prominent hump.\(^4,20\) In addition, frequent features of a heavy thick skin envelope, bulbous tip, and wide bony middle vault often impart the impression of an overall large nose, which on cursory inspection may seem overprojected. We tested this premise using the Goode ratio, which is the most widely quoted and used objective method to assess nasal tip projection.\(^17,21,22\) Despite observations of significant variation in ranges of projection among different cultures and ethnicities, little normative data exist. Rohrich and Ghavami\(^2\) cited 0.67 as an ideal tip height to length ratio in the Middle Eastern nose and 90 to 95 degrees as the desired CLA. By comparison, traditionally accepted parameters for CLA are 95 to 105 degrees for a Caucasian female and 90 to 95 degrees for a male.\(^23\) We found that using the standard Goode ratio calculation, only 45% of our subjects were overprojected. Of the 71 patients described by Rohrich and Ghavami\(^2\) (sex unspecified), 79% were underprojected, likely reflective of how the Goode ratio was defined. In addition, we did not find a strong relationship between either ANSL or SCE with the Goode ratio. A potential explanation for this may be the fact that the ANSL represents a relatively small contribution to septal elevation (projection), while tip projection may be more related to the product of rostral-caudal and dorsal-ventral measurements (ie, total septal area) and not the restrictive measurement used in this study (ie, SCE). In lieu of our findings, and consequent to the illusionary impact of overprojection attributable to a prominent ANS and obtuse CLA, it has been our practice to correct these features prior to any adjustments in tip position. This approach would be independent of ethnic derivation.

The morphology of the caudal septum, ANS, maxilla, upper incisor inclination, and medial crural footplate divergence influences profile relationships of the upper lip and columella. A prominent ANS makes identification of the subnasale (used in Goode ratio calculation) difficult and biases the slope of the vertical limb of the upper lip, leading...
to a more obtuse angle. The dimension and orientation of the septum can also influence the CLA. While some believe ANS prominence is more associated with an obtuse angle than an increase in septal length,24 others relate it more to the effects of dorsal nasal length. In addition, it is believed the caudal end of the septal cartilage more likely influences columellar shape rather than the ANS.25 In this study, we attempted to evaluate the influence of the ANSL and SCE upon either the CLA or CSA. In all methods of statistical analysis that we employed, neither SCE nor ANSL had a statistically significant effect on CSA or CLA; the explained variation in angles with these 2 measures was very small. This finding was surprising to us and would seem to suggest that other factors not measured in this study influence the CLA, and described herein,23 may be affecting these associations.

The strengths of this study include a single surgeon’s experience with a uniform approach and consistent method of measurement in a relatively large and ethnically comparable patient population. Weaknesses of the study include the limitations of using Goode ratio parameters that have not been established for the Middle Eastern population and that possible sex differences could not be explored thoroughly given the number of men in the study, thereby introducing potential selection bias. All the study patients sought surgery and may not be representative of all individuals of Middle Eastern descent. Methodologic criticism may include that ANS measurements were taken from the anterior-most pyriform ledge rather than the maxillary palatine suture and that the CSA may correlate with changes at the posterior septal angle rather than the SCE where we measured.

**Conclusion**

The current study shows that among predominantly Iraqi female participants, there is a strong positive association
between the values of SCE and ANSL. Neither SCE nor ANSL was very useful in predicting the Goode ratio (either its numeric variable or its dichotomization into overprojection or not). In addition, neither SCE nor ANSL was useful in predicting CLA or CSA. Future studies that consider possible sex differences and the complex morphology of other bony or soft tissue structures, such as the lower lateral cartilages, will lend better insight into Middle Eastern nasal dynamics.

**Author Contributions**

Richard L. Arden, study conception and design, surgical measurements, drafting of manuscript, revision, final approval; Brett J. Baldwin, study conception, data acquisition, drafting of manuscript, revision, final approval; Mary P. Coffey, data analysis, statistical analysis, drafting of manuscript, revision, final approval.

**Disclosures**

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