

Association of nasal morphology in skeletal maxillary growth pattern: a cephalometric study

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ABSTRACT

Background: The morphology of the nasal and craniofacial structures is a significant characteristic of the facial appearance of an individual. The soft tissue facial form depends on the hard tissue skeletal structures. The nasolabial angle depicts a close relationship between the lips and the nose, affecting the facial profile. There is however less data in orthodontic literature regarding the relationship between the nasal morphology and the sagittal and vertical maxillary growth pattern. **Aim and Objectives:** 1. To evaluate the relationship between nasal morphology and skeletal maxillary growth pattern. 2. To evaluate the relationship between the degree of upturn of the nose and the inclination of the palatal plane.

Materials and Method: An analysis of 70 lateral cephalograms of adults between the ages of 17 and 25 years with no previous history of trauma, surgical intervention, or congenital disorders was conducted. A total of 16 parameters, including 10 craniofacial and 6 nasal parameters were measured on each lateral cephalogram. The Pearson correlation analysis was used to determine the correlation between the above parameters.

Results: Highly positive correlations were present between the nasal length and inclination of the palatal plane, upper anterior facial height and maxillary length. Nasal length has a highly positive correlation with nasal depth however a negative correlation was observed with the nasal upward tip angle and nasal tip angle.

Conclusion: The clinical significance of this study is that the facial form, facial prominence and nasal length are associated with the height and length of the maxilla. Nasal length was seen to be significantly positively correlated to maxillary length, upper anterior facial height and inclination of the palatal plane.

Keywords: Sagittal and Vertical maxillary skeletal pattern, Nasal length, Nasolabial angle, Upturned Nose.

INTRODUCTION

The nose constitutes the most prominent part of the profile and occupies the most visible position in the face [1]. The nose, combined with the lips and chin influences the overall facial harmony [2]. The nose dominates the middle third of the face and is in close harmony with the lips and chin. It denotes the characteristic facial appearance of an individual [3]. Standardized lateral cephalograms are standard tools to diagnose the vertical and sagittal discrepancies in the skeletal, dental and soft tissues

[4] and determine their relation to the surrounding structures.

Excessive nasal growth, both quantitatively and qualitatively, during orthodontic treatment produce obvious nasal imbalance [5]. A "big nose" implies a nose larger than average [6]. It is a dominating feature of the face, and greatly influences the degree of profile convexity [7]. As the soft tissue profile can be altered by both growth and orthodontic

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treatment, the orthodontist must have an understanding of not only the growth changes expected in the facial structures but also those occurring as a result of orthodontic treatment [8].

Orthodontists must consider the nose, its growth potential and its shape changes in profile analysis and treatment planning^[9]. When nasal development is excessive; growth produces an even more convex profile^[9]. Nasal growth proceeds at a relatively constant rate into adolescence and is almost completed by the age of 16 in girls and 18 in boys^[10]. There are a variety of measurements to express the form and position of the nose and its relative position to facial structures^[11]. The choice of treatment plans would depend on a thorough understanding of what happens during various periods of growth and when the facial growth can be considered complete.^[12]

The goal of orthodontic treatment targets the improvement of a patient's life through enhancement of dentofacial functions and esthetics and to reduce orthodontic treatment duration is an issue of importance, particularly for adults^[13-16]. Age-related changes in the jaws and soft tissues are important considerations in orthodontic treatment planning for both orthodontists and general dentists.^[17] Direct measurements have been used to measure the growth of the nose but the lack of underlying bony support limits its accuracy^[18]. The convexity of the face increases with age, as nasal growth mainly occurs in the antero-inferior direction^[19].

The present study aims to determine the relationship between the nasal morphology and the sagittal and vertical maxillary growth pattern.

MATERIALS AND METHODS

Sample selection

Based on the article Krishnaveni S. et al^[20], published in the International Journal of Oral Health and Medical Research in 2017, the correlation coefficient derived was 0.436. With an alpha error of 1% and a power of 95%, the corresponding Z values of the given alpha and beta values were 2.5 and 1.6. On calculation, the required sample size was found to be 69. In this study, lateral cephalograms from 70 patients between the ages of 17 and 25 were obtained from the hospital archives

(XXXX). The Ethical Committee approved the clearance for the study.

Inclusion Criteria

Patients in the age group of 17 to 25 were selected with completely established permanent dentition except third molars. Anatomically normal and vital teeth are present with no gross craniofacial deformities.

Exclusion Criteria

Patient with no periodontally compromised condition were selected with no history of trauma and past history of orthodontic treatment or surgery and gross nasal deformity. Patients with supernumerary teeth and with missing teeth were not included.

This study was conducted to evaluate the Association of nasal morphology in relation to skeletal maxillary growth pattern.

Cephalometric analysis

Ten craniofacial and six nasal soft tissue parameters were identified on the standardized lateral cephalometric radiographs. A 3H pencil was used to trace the cephalometric radiographs on acetate tracing paper in a dark room. All cephalometric radiographs were taken with the lips relaxed, which is a normal natural position and allowed a more accurate structure of the lip and were traced on 0.003 inch matte acetate tracing paper^[21]

The skeletal parameters for the measurements are as follows:

GoGn-SN: The inclination of the mandibular plane to the cranium.

SN-Pp: The angle between the Sella-nasion plane and the ANS-PNS line

S-Go: The posterior facial height.

N-Me: The anterior facial height.

N-ANS: Anterior maxillary height.

ANS-Me: The lower anterior facial height.

Angle of inclination: The angle between the perpendicular drawn from N' on the Se-N' line (entry of Sella soft tissue nasion) and the palatal plane.

SNA: The angle formed by Sella-Nasion-Point A

N perpendicular to A: The distance from Point A to the nasion perpendicular

Maxillary length: The distance between Condylion to Point A

The following soft tissue landmarks were identified^[22]

Soft tissue nasion (N): The point of greatest concavity in the midline between the forehead and the nose.

Pronasale (Pr): The tip of the nose.

Posterior columella point (PCm): The most posterior point of the lower border of the nose at which it begins to turn inferiorly to merge with the philtrum of the upper lip.

Subnasale (Sn): The deepest point at which the columella merges with the upper lip in the midsagittal plane.

Labrale superius (Ls): The point indicating the mucocutaneous border of the upper lip.

Using the soft tissue landmarks the following reference planes were measured^[23,24]

Nasal length (N Lth): The distance between N' and Pr.

Nasal depth (N Dpt): The perpendicular distance between Pr and the line drawn through N' to Sn.

Nasolabial angle (NLA): The angle formed by the intersection of the PCm tangent (a tangent drawn from PCm along the lower border of the nose at the approximate middle third) and the PCm-Ls line.

Nasal upward tip angle (UNLA): The posteroinferior angle formed when the PCm tangent extended anteriorly to intersect the Frankfurt horizontal plane.

Upper lip inclination (LNLA): The anteroinferior angle formed by the PCm-Ls line extended superiorly to intersect the Frankfurt horizontal plane.

Nasal tip angle (NTP): the angle formed by the axis of the dorsum and PCm tangent.

Statistical Analysis:

The recorded data was compiled and entered into the database using Excel 2007 and evaluated using the Statistical Package for Social Sciences (SPSS for Windows, Version 16.0). The statistical analysis of the observations includes descriptive and inferential statistics. Normality assumptions of data

distribution were tested by the Shapiro-Wilks test. Data was summarized by mean and standard deviation. Pearson correlation coefficient test was used to determine linear correlations between maxillary skeletal measurements and nasal parameters. The one-way analysis of variance (ANOVA) is used to analyze nasal parameters. A p-value of less than 0.05 was considered to be statistically significant.

RESULT

During this research, 70 cephalograms of patients between the age of 17- 25 years were assessed. Table I depicts the Mean, Standard Deviation, Maximum and Minimum values of each parameter measured. The mean GoGn-SN angle length was found to be 27.520 ± 5.277 . The mean posterior facial height was found to be 74.350 ± 7.478 . The mean anterior facial height was found to be 109.600 ± 5.637 . The mean Anterior maxillary height was found to be 41.320 ± 3.778 . The mean lower anterior facial height was found to be 67.500 ± 5.776 . The mean Angle of inclination was found to be 45.650 ± 4.89 . The mean SN-Pp angle was found to be 4.750 ± 2.4 . The mean SNA value was found to be 75.950 ± 2.156 . The mean N perpendicular to A value was found to be 0.600 ± 2.365 . The mean maxillary length was found to be 76.780 ± 5.254

The mean nasal length was found to be 46.72 ± 3.795 whereas the mean nasal depth was found to be 17.520 ± 2.04 . The mean nasal labial angle was found to be 87.620 ± 14.07 and the mean nasal upward tip angle was found to be 25.860 ± 7.982 . The mean upper lip inclination length was found to be 59.520 ± 8.227 . The mean nasal tip angle was found to be 82.560 ± 5.198 . High positive correlations were present between nasal length and three variables including the inclination of the palatal plane, anterior maxillary height and maxillary length. Nasal length had a high positive correlation with nasal depth, however negative correlations were observed between the nasal upward tip angle and nasal tip angle.

Nasal depth depicted a highly significant correlation between upper anterior facial height and anterior facial height. Nasal depth demonstrated a significant negative correlation with the nasal upward tip angle and, a highly negative correlation with the nasal tip angle. The nasolabial angle did not show any

significant correlation with skeletal parameters. However, it showed a highly significant correlation with nasal tip angle, nasal upward tip angle, and inclination of the upper lip.

The nasal upward tip angle shows a positive correlation with the angle of inclination and SnPp inclination. The nasal upward tip angle had a significant positive correlation with the nasal tip angle. Upper lip inclination shows no correlation with the skeletal variable but demonstrates a positive correlation with the nasolabial angle.

Table 1 : Mean, S.D and Confidence Interval Minimum and Maximum Value.

		Nlth	Ndpt	Nla	unla	Lnla	Ntp
GoGn-Sn	R	0.212	0.131	-0.007	-0.077	0.075	-0.09
	p value	0.192	0.415	0.961	0.627	0.635	0.635
S Go	R	-0.075	0.21	-0.22	-0.079	-0.07	-0.15
	p value	0.655	0.151	0.155	0.586	0.721	0.280
N Me	R	0.133	.462	-0.224	-0.135	-0.017	-0.211
	p value	0.425	0.002	0.162	0.405	0.905	0.175
Nans	R	.437	.465	-0.121	-0.167	0.155	-0.131
	p value	0.007	0.002	0.452	0.315	0.350	0.405
Lafh	R	-0.067	0.281	-0.045	0.017	-0.007	-0.107
	p value	0.687	0.071	0.770	0.925	0.975	0.517
AOI	R	-0.214	-0.105	-0.027	.41	-0.040	0.217
	p value	0.17	0.512	0.857	0.004	0.795	0.55
SnPp	R	.342	0.187	-0.040	.341	0.025	-0.217
	p value	0.01	0.247	0.802	0.017	0.895	0.177
Sn A	R	0.104	-0.022	-0.262	0.115	-0.21	-0.15
	p value	0.530	0.884	0.1	0.490	0.17	0.499
N perp A	R	0.181	-0.017	-0.181	0.045	-0.255	-0.055
	p value	0.257	0.927	0.261	0.7	0.117	0.739
Max Lth	R	.391	0.147	-0.119	0.149	-0.221	0.067
	p value	0.011	0.365	0.47	0.37	0.157	0.677

Table 2 : Correlations of Nasal Parameters with vertical facial skeletal parameters .

Sl. N	Parameters	Mean	S.D	Confidence Interval (95%)	Min	Max
1	N Lth	46.720	3.795	42.51-46.34	35	70
2	N Dpt	17.520	2.04	15.65-16.8	12	20
3	NLA	87.620	14.07	84.12-93.13	60	118
4	UNLA	25.860	7.982	21.29-26.71	1	36
5	LNLA	59.520	8.227	62.71-68.74	40	83
6	NTP	82.560	5.198	78.47-83.33	61	94
7	GoGn-SN	27.520	5.277	29.22-33.43	14	43
8	S-Go	74.350	7.478	72.26-77.04	58	95
9	N-Me	109.600	5.637	111.49-116.31	98	126
10	Nans	41.320	3.778	48.12-50.53	39	60
11	Lafh	67.500	5.776	64.92-68.48	54	76
12	AOI	45.650	4.89	84.24-87.46	65	98
13	Snpp	4.750	2.43	6.14-7.76	0	11
14	Sn-A	75.950	2.156	82.27-83.63	77	87
15	N perp A	0.600	2.365	-0.74 - 0.94	-7	5
16	Max Lth	76.780	5.254	84.94-88.61	74	99

Table 3 shows the Pearson product-moment correlation coefficients between the nasal variables. Significant correlations were seen between the following skeletal and soft tissue nasal variables.

		N Lth	N Dpt	NLA	UNLA	LNLA	NTP
N Lth	Correlation	1	.39	-0.135	-.399	0.245	-.321
	p value	.	0.011	0.417	0.015	0.13	0.047
N Dpt	Correlation		1	-0.105	-.327	0.277	.439
	p value		.	0.527	0.035	0.095	0.005
NL A	Correlation			1	.47	.677	.579
	p value			.	0.002	0.000	0.000
UN LA	Correlation				1	-0.035	.875
	p value				.	0.841	0.000
LN LA	Correlation					1	0.107
	p value					.	0.507
NT P	Correlation						1
	p value						.

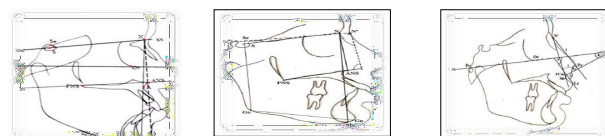


Fig 1: vertical parameters, Fig 2: Sagittal parameters, Fig 3: Nasal Parameters

DISCUSSION

Subtelny first documented the downward and forward growth of the nose that occurs during maturity [25]. His research revealed that the nose grows more vertically compared to its growth in the sagittal dimension. This vertical growth continues until the age of 16 in females and 18 in males. These findings were subsequently supported by studies conducted by Meng et al [26] and Posen et al.[27]. However, long-term studies by Behrents[28] propose that a considerable amount of nasal growth occurs even after puberty. Robison et al. [29] believed that nasal forms closely follow that of the underlying skeletal structure.

The nasolabial angle remains an essential component of the soft tissue profile and serves as an excellent clinical and cephalometric parameter for assessing the anteroposterior position of the maxillary dentition. It is an important facial feature that influences aesthetics. It is formed by the intersection of two lines: one connecting the nasal tip to the upper lip and the other connecting the

upper lip to the base of the nose. This angle can vary significantly among individuals and plays a role in overall facial harmony. According to Lo and Hunter^[30] change in the nasolabial angle is an important consideration in treatment planning.

The present study investigates the association between nasal morphology and skeletal Maxillary growth patterns. High positive correlations were observed between nasal length and three variables: the inclination of the palatal plane, anterior maxillary height, and maxillary length. Specifically, nasal length exhibited a strong positive correlation with nasal depth. Negative correlations were found between nasal length and the nasal upward tip angle and nasal tip angle.

Additionally, nasal depth showed a highly significant correlation with upper anterior facial height and anterior facial height. Notably, nasal depth had a significant negative correlation with the nasal upward tip angle and a highly negative correlation with the nasal tip angle. Interestingly, the nasolabial angle did not exhibit any significant correlation with skeletal parameters. Nevertheless, it demonstrated a highly significant correlation with the nasal tip angle, nasal upward tip angle, and inclination of the upper lip.

Furthermore, the nasal upward tip angle displayed a positive correlation with the angle of inclination and SnPp inclination. Moreover, it had a significant positive correlation with the nasal tip angle. On the other hand, upper lip inclination did not correlate with skeletal variables but did show a positive correlation with the nasolabial angle. The findings of this study are in contradiction with those found by Gulsen et al, wherein no correlation was demonstrated between the nasal structure and skeletal parameter. Longer noses are expected to have greater nasal depths, but short noses are generally straighter with decreased nasal depths^[31]

Based on these findings one can expect a long nose with an increased nasal prominence in sagittal and vertical maxillary excess and a short nose with decreased nasal prominence in sagittal and vertical maxillary deficiency^[32]. The nasolabial angle when correlated with sagittal skeletal parameters shows a negative correlation with SNA, N perpendicular to A and the length of the maxillary base. It shows no

significant correlation with sagittal or vertical maxillary skeletal pattern.

The nasal upward tip angle shows a positive correlation with the angle of inclination and inclination of the palatal plane but when correlated with vertical skeletal parameters it shows a negative correlation with anterior maxillary height. An upturned nose in an adult individual was significantly positively correlated with anti-clockwise rotation of the maxilla. This fact was further supported by an increase in the AOI leads to increase in the UNLA.

CONCLUSION

The study highlights that facial form, facial prominence and nasal length are linked to the height and length of the maxilla. Nasolabial angle alone may not accurately indicate mid-face vertical discrepancies. When the upper component of the nasolabial angle is associated with reduced nasal length in an adult, it could suggest a change in the inclination of the palatal plane. These findings emphasize the importance of considering facial features in orthodontic diagnosis and treatment planning. Nasal length is significantly and positively correlated with maxillary height and length. An upturned nose in an adult is associated with anti-clockwise rotation of the maxilla. The anteroposterior (sagittal) length of the maxilla has a greater impact on the nasal pattern than its position. Nasal length and depth are positively correlated with the length of the maxillary base. The nasolabial angle has a negligible negative correlation with maxillary base length, while the nasal tip angle shows a statistically low negative correlation. In summary, understanding these relationships can inform orthodontic treatment decisions and enhance patient care.

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