Correlation of Nasal Morphology to Various Skeletal Patterns: A Retrospective Study

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Abstract

Introduction: The distinctiveness of a person may be seen in their face. Numerous facets of the persona, such as personality, temperament, general health, and stress levels, might be hinted at. In terms of biology, the face phenotype is a result of genetics and environment and represents characteristics of populations in certain places. As a result, the face is a dynamic structure that can convey a wide spectrum of expression, from extremely subtle to considerably exaggerated. Even the slightest variations in expression can alter how others see something. Facial appearance is largely influenced by the shape of the nose. Studies on the relationshipbetween nasal structures and craniofacial configurations are limited. **Objective:**The present study was carried outto analyze the association of nasal cephalometric variables with skeletal structures.**Methods:**This retrospective study was conducted amongst the individuals living in Mangalore city. Cephalometric and nasal analysis was performed on 65 patients who came for an orthodontic treatment (aged 18–30 years). The evaluation was carried out using parameters like Soft tissue convexity, Nasal length, nasal bone angle, nasolabial angle, Nasomental angle, and nasal depth. Pearson's correlation coefficients and one-wayANOVA—to find correlations between the groups.**Results:**Correlation between craniofacial relation and nasal bone anatomy exists. An acute nasal bone angle is seen in the Class II skeletal pattern.Sexual dimorphism has been found for nasal parameters: the nasal bone angle is significantly smaller in females.

Keywords: nose; nasal morphology; cephalometry; orthodontics, nasal bone angle

Background

India is a diverse country with mixed communities. A person's face is unique to itself. Biologically, the play between the genetic and environmental factors gives rise to variations in the facial phenotype of an individual.(1) Every person is categorized by his/her ethnicity. There are certain facial features that define each person into these categories. Amongst these, nasal morphology plays a significant role.

The nose can be upturned or downturned, and it might have a hump or not(2). Facial euphony is a result of harmony between the nose, lips, and chin in their ideal proportions. The criteria for a perfect nose include a straight nasal bridge, dorsal cartilage, nasal tip cartilage, and alar rims that are 1-2 mm above the columella in a lateral profile(3–6).

As beauty is subjective, the definition of an ideal nose differs for different races, sexes and ethnicities. Nasolabial angle (NLA) is a defining parameter that determines the shape of the nose in cephalometric analysis of the soft tissue. Some of the authors have considered NLA as an excellent marker for revealing the sagittal position of the maxilla, both clinically and as a cephalometric parameter(7,8). The Nasolabial angle is divided into two angles by a line parallel to Frankfort horizontal plane passing through the Subnasale (Sn); which gives the upper nasal tip angle and the upper lip inclination angle(8,9). Nasolabial angle was divided into two components by Lo and Hunter(8).(a) The nasal upward tip angle refers to the angle created when a line is drawn from the most posterior point of the lower border of the nose (posterior columella point or PCm) and extended forward to intersect with the Frankfurt horizontal plane or the lower border of the nose to the Frankfurt horizontal plane. (b) The upper lip inclination, on the other hand, is the angle formed by the line connecting the posterior columella point (PCm) to the labrale superius (the highest point of the upper lip) with the Frankfurt horizontal plane. This angle represents the inclination or tilt of the upper lip in relation to the Frankfurt horizontal plane(10).

The shape of the nose is associated with different skeletal classes. Class II individuals typically have a prominently elevated nasal dorsum and projecting nasal bone(2,11–13). In contrast, Class III individuals tend to have a concave dorsum, while Class I individuals exhibit a straight dorsum of the nose(12). However, the amount of nasal development does not seem to be influenced by the skeletal class. The growth of the nose appears to be relatively independent of the underlying skeletal hard tissue (skeletal classes)(14).

Studies were carried out to evaluate the relation between the nasal upward tip and vertical maxillary skeletal pattern. It was discovered that there is an upward maxillary plane inclination in a patient with an upturned nose(10). In a study by Robinson et al.(2), a correlation between the nasal shape and underlying skeletal pattern was found using lateral cephalograms. On the contrary, Fitzgerald et al.(9), found no correlation between skeletal measurements and soft tissue parameters in the well-balanced profile. During orthodontic treatment where extractions of premolars are indicated, defining the nasal relation to the lips plays a key role. In a patient with upturn nose, extraction of premolars would be risky as the nasolabial angle would increase further giving an older appearance to the patient. Hence, the purpose of this study was to evaluate (1) correlations between nasal and skeletal parameters; and (2) sexual dimorphism of nasal parameters.

Methodology

This retrospective study was conducted among adults living in the Mangalore city. Ethical clearance to conduct the study was taken from the Institutional Ethics Committee. The participants were selected by convenience sampling method. They had no history of orthodontic treatment.

Data collection

In this study a total of 65 participants were divided into two groups, viz., group 1 consisted of Class I skeletal relation and group 2 consisted of Class II skeletal relation. Permission to use the records from the repository was obtained from the Head of the department. The Confidentiality of the participants was maintained throughout the study.

Cephalometric Evaluation

The cephalometric analysis was carried out using Dolphin Software and lateral cephalograms taken for orthodontic diagnosis purpose.

Operational definitions:

- Malocclusion groups:
  - o Class I:
    Maxilla and mandible are in harmonious relation with eachother (angle between pt A and pt B: 2° to 4°)
    Lower incisal edges occlude with or lie immediately below the cingulum of the upper incisors
  - o Class II: Maxilla lies ahead of the mandible (angle between pt A and pt B: > 4°)

Parameters used in the study:

Angular measurements:

1. NLA - Angle between the points ctg, Sn, UL
2. N/FH – Angle between the points ctg, Sn, FH plane
3. L/FH - Angle between the points UL, Sn, FH plane
4. Nasomental angle - Angle between the axis of the dorsum and the Pr-WPg line
5. Nasal bone angle - The posterior angle between the lines N1-N2 and N2-R
6. Soft tissue convexity angle - Angle between the lines G'-Sn and Sn-WPg line

Linear measurements:

1. Nasal Length - Distance between the N' point and the Pr point
2. Nose Depth - Perpendicular distance between Pr and the N'-Sn line

Cephalometric analysis was performed using a specialized computer software (Dolphin software).Analysis of nasal morphology was made according to Gulsen et al(4).The nasal and cephalometric landmarks used are presented in Figure 1 and described in Table 1. All cephalometric variables used are listed and described in Table 2

Data Analyses

Statistical analysis was performed using SPSS software, version 22.0(15). Data distribution normality was assessed using KolmogorovSmirnov test. All analyses were performed using the statistical significance level at $p \leq 0.05$. Correlations between quantitative variables were assessed using Pearson's correlation coefficient (for data of normal distribution).

Results

A total of 65 patients were selected for the study. Of them, 38 showed class I skeletal class and 29 showed class II skeletal class. The mean age was 21.85 ± 3.68; and 55.4% were females. Characteristics of the study group, according to age, sex, and skeletal Class are presented in Table 3. Correlation of soft tissue convexity to various nasal parameters are presented in Table 4. Comparison of both the groups with its p values is demonstrated in Table 5.

In the study group, a weak positive correlation with soft tissue convexity was found for the following parameters: nose length, nose depth and age.A weaknegativecorrelation for: nasolabial angle and a very weak negative correlation for: Nasal bone angle. Significant differences were found between the sexes. Nasomental angle (NMA) was significantly smaller in females. The average NLA is 98 ± 10.4 in females and 98.7 ± 13.34 in males, no significant differences were found between the sexes.

On using Independent t test to compare the parameters between the groups. Nasal parameters like N/FH, NLA, and Nasal bone angle had significant difference between the different classes with $p<0.05$. Figure 2 shows a graphical comparison of nasal bone angle between the two groups.

Discussion

Understanding the relationships between nasal parameters and skeletal structures can be beneficial for orthodontists and maxillofacial surgeons when it comes to diagnosing and planning treatments. For instance, parameters such as nose depth (1) and (2), nasal length, SFC (soft tissue nasion to facial plane angle), NMA (nasofrontal angle), NBA (nasobasal angle), and hump play crucial roles in determining the size and shape of the nose. Additionally, the NLA angle (nasolabial angle) is considered when making decisions about extraction treatments.

The size of a patient's nose holds significance for maxillofacial surgeons, as it can have an impact on both occlusion (the alignment of the teeth) and the patient's facial profile. By understanding these correlations, medical professionals can make more informed decisions and develop effective treatment plans to achieve desired outcomes in both orthodontic and maxillofacial procedures.

In this current research, the SFC angle demonstrated a statistically significant positive correlation with ANB, which is consistent with previous studies conducted by Arshad et al. and Gulsen et al(3,4). These findings suggest that there is a relationship between the SFC angle and skeletal classes, providing valuable insights into the association between nasal parameters and skeletal structures.

In the current study, there was significant difference in the nasolabial angle within the two groups but it is contrary to the results by Perovic et al.(16). The study by Perovic et al., did not find any significant differences in the NLA angle between patients with skeletal Class I and those with other skeletal patterns (Class II/1, Class II/2, Class III)(16). In other words, the NLA angle was similar among individuals with different skeletal classes, suggesting that this particular nasal parameter does not vary significantly based on the underlying skeletal structures.

Nasal development reaches completion earlier in females, typically by the age of 16, while in males, it is usually finished by the age of 18(10,11,17–19). However, according to Meng et al., nasal growth in males continues beyond the age of 18(17). Soft tissue development in females mostly stops around the age of 12, while in males, it continues until approximately the age of 17(14).

As individuals mature, the nose plays a significant role in contributing to the overall increase in soft tissue profile convexity. The nose continues to grow both forward and downward during maturation, leading to a more prominent appearance in relation to the facial profile.

According to Clements, orthodontic treatment exaggerated the nasal imbalance(13). Throughout the growth and developmental period, the soft tissue facial profile, excluding the nose, tends to remain relatively stable in terms of its degree of convexity. However, when the nose is considered in the profile evaluation, the convexity of the soft tissue profile shows a noticeable increase with growth. Notably, male subjects experience a more significant increase in nose depth compared to female subjects(11,17).

In summary, while the overall soft tissue profile remains stable, the inclusion of the nose in the assessment contributes to a significant increase in convexity as individuals grow and mature(20).

Various studies were in concordance with the present study about no statistical significant difference in nasolabial angle between males and females(9,21).

Conclusion

1. Positive correlation exists between nasal morphology and sagittal jaw configuration.
2. Nasal parameters that showed significant differences within Class I and Class II skeletal relations are nasolabial angle, nasal bone angle and nasal base inclination.
3. Acute nasal bone angle is observed in Class II patients.
4. Sexual dimorphism has been observed in nasal parameters, with females exhibiting a significantly smaller nasal bone angle compared to males.

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Conflict of interest:
The authors declare no conflict of interest

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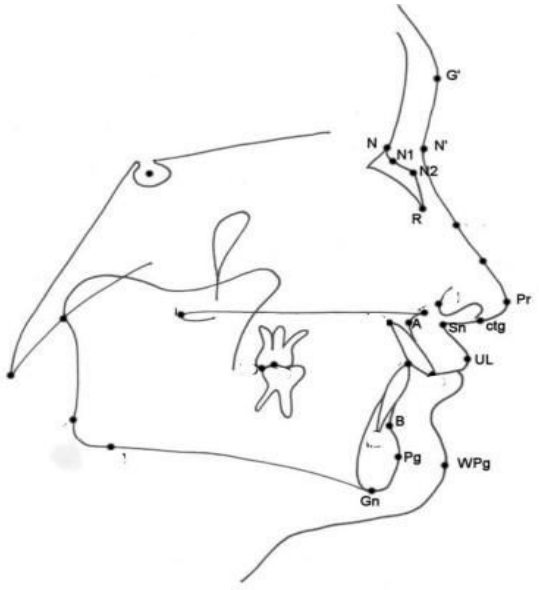

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Figure 1. Nasal and cephalometric landmarks

Table 1. Nasal and cephalometric landmarks

	Landmark	Definitions
N’	Soft tissue nasion	Soft tissue point—borderline between the forehead and the nose
St	Supratip	Soft tissue point halfway between the Midnasale point and the Pronasale points
Pr	Pronasale	Tip of the nose (soft tissue point)
Sn	Subnasale	Soft tissue point between columella and upper lip
WPg	Pogonion	The most prominent point on the soft tissue chin
G’	Soft tissue glabella	Soft tissue point on the inferior part of the forehead between the eyebrows
N1	Nasion 1	The most receding point of the frontal curvature on the nasal bone
N2	Nasion 2	The most protruding point of the frontal curvature on the nasal bone
R	Rhinion	The most prominent and inferior point on the nasal bone
UL	Upper Lip	The most protruding point of the upper lip
Ctg	Columella	The most prominent point on the Sn-Pr curve, borderline between lower part of the nose contour and nasal tip
Po	Porion	The point on the human skull located at the upper margin of each ear canal (external auditory meatus)
Or	Orbitale	The lowest point on the inferior bony margin of the orbit

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Table 2. Cephalometric and nasal variables

Abbreviation (unit)	Name	Definition	Interpretation
N'–St (mm)	The axis of dorsum	Distance between the soft tissue nasion point and the supratip point	Length of the nasal dorsum
N'–Pr (mm)	Nasal length	Distance between the N' point and the Pr point	Total nasal length
Nose depth (mm)	Nose depth	Perpendicular distance between Pr and the N'-Sn line	Sagittal position of the nose tip referring to the face
NMA (◦)	Nasomental angle	Angle between the axis of the dorsum and the Pr-WPg line	Relation between nasal dorsum inclination and chin position
SFC (◦)	Soft tissue facial convexity	Angle between the lines G'-Sn and Sn-WPg line	Profile convexity
NboneA (◦)	Nasal bone angle	The posterior angle between the lines N1-N2 and N2-R	Curvature of the nasal bone
NLA (◦)	Nasolabial angle	Angle between the points ctg, Sn, UL	Relationship between the upper lip and columella
FH plane	Frankfort's horizontal plane	Line joining Porion and Orbitale	-
N/FH	Nose to Frankfort's horizontal	Angle between ctg, Sn and FH	Inclination of the nose to the horizontal plane
L/FH	Upper lip to Frankfort's horizontal	Angle between FH, Sn and UL	Inclination of the upper lip to the horizontal plane

Table 3. Characteristics of the study group (n=65)

Features		Values
Age	Mean ± SD	21.85 ± 3.68
Sex	Female	36 (55.4%)
	Male	29 (44.6%)
Skeletal Class	I	38 (58.5%)
	II	27(41.5%)

Table 4.Pearson's correlation between soft tissue convexity and other parameters (class 1 and class 2)

Class (Soft tissue convexity)			Age	Nasal length	Nasal depth	N/FH	L/FH	NLA	Nasal bone angle	Nasomental angle
Class 1			.029	.263	.375	-.329	-.529	-.620	-.074	.390
Class 2			-.156	-.237	-.165	-.160	-.076	-.144	.424	.749

Table 5. Comparison of nasal parameters between class 1 and class2:

	Class	N	Mean	Std. Deviation	p-value
Age	1	34	21.85	3.686	0.452
	2	25	22.52	2.815	
Nasal length	1	34	38.09	13.090	0.816
	2	25	37.40	7.837	
Nasal depth	1	34	14.44	4.762	0.827
	2	25	14.20	3.202	
N/FH	1	34	26.24	7.148	0.002
	2	25	31.36	4.071	
L/FH	1	34	69.03	7.086	0.419
	2	25	70.96	11.126	
NLA	1	34	95.18	9.662	0.010
	2	25	102.48	11.199	
Nasal bone angle	1	34	88.59	10.988	<0.001
	2	25	71.88	10.647	
Nasomental angle	1	34	125.94	5.929	0.229
	2	25	127.64	4.290	
Soft tissue convexity	1	34	164.12	3.804	0.211
	2	25	162.48	6.111	

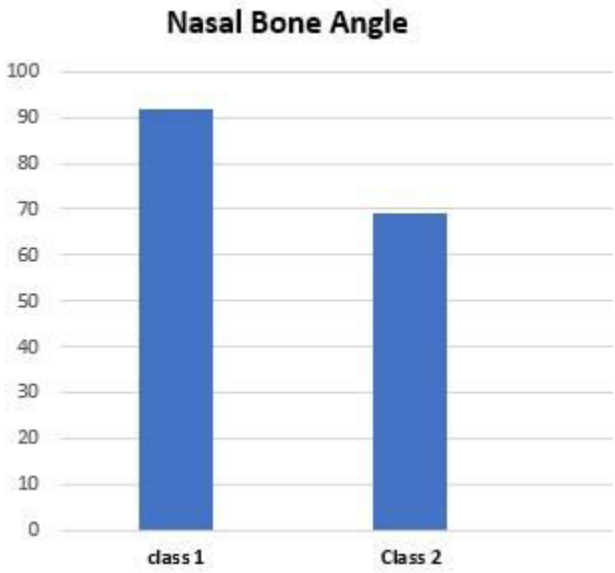

Figure 2. Graph showing comparison of nasal bone angle between the two groups.