ORIGINAL ARTICLE

COMPARISON OF NASAL PROFILES IN VARIOUS SKELETAL PATTERNS

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Background: The aim of this study was to determine any significant difference in nasal profiles amongst subjects in sagittal and vertical skeletal patterns in a sample Pakistani population, and to determine gender dimorphism if any. **Material:** The sample was divided into three sagittal and groups, namely skeletal Class I, II, and III, and three vertical groups, namely, normo-divergent, hypo-divergent and hyper-divergent vertical skeletal patterns. On way ANOVA was used to find any difference in nasal profiles amongst vertical and sagittal skeletal patterns, and to assess gender dimorphism, respectively. **Results:** Statistically significant differences were found between Skeletal Class I, II and III for naso-labial angle, naso-mental angle and soft tissue facial convexity. Furthermore, statistically significant differences were also obtained between males and females for nasal length, nasal depth, columella convexity and nasal bone length. Statistically significant differences were observed for nasal depth 2 and naso-labial angle in the vertical groups. **Conclusions:** Skeletal Class I, II, and III subjects have different nasal profiles. Nasal profiles are significantly different for males and females; hence it should be taken into consideration while planning ideal treatment for patients. Different vertical patterns are also associated with different nasal forms. It is recommended that further research be done to establish norms in our population for nasal profile.

Keywords: Nasal profile, Vertical skeletal pattern, Sagittal skeletal pattern

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INTRODUCTION

The world of orthodontics is the world of aesthetics governed solely by finesse and aesthetic perfections. The modern world seeks treatments that can improve their overall outlook and social standing. Hence, the psychosocial impacts of an aesthetically pleasing face cannot be denied. However, a face can be described as attractive or unattractive when proportions are close to population's average values. Over the years, health care profession has evolved and experienced a paradigm shift from disease prevention to maintaining quality of life. This is known as health related quality of life (HRQoL). Its purpose is to improve and maintain the quality of life as the major goal of most treatment provided, as dento-skeletal problems are neither diseases nor pathologic conditions.[1]

The ultimate treatment plan in orthodontics stems from an ideal orthodontic diagnosis which is divided into clinical, radiological and model based analysis that lays emphasis first on the soft tissue patterns and then the hard tissues. This is known as the soft tissue paradigm and its approach is to place the teeth and jaws in such a position that they principally support the soft tissues and improve an individual's esthetics.[2] Soft tissue proportions become more important as skeletal and dental deviations from normal become severe. Although, initially according to the Angle paradigm hard tissues were the focus of treatment, it was observed that correction of hard tissues only, without any consideration of the soft tissues led to un-aesthetic skeletal profiles.[2] This occurred due to limiting factors in soft tissues produced by underlying hard tissue modifications[2], therefore, clinical evaluation of soft tissues becomes significant.

A straight well balanced human face has been aptly divided into three equal vertical proportions which were established by the artists of the Renaissance period, primarily da Vinci and Durer. They concluded that the distance from the hairline to the base of the nose (known as the upper one third), base of the nose to bottom of the nose (known as the middle one third), and nose to chin (known as lower one third) should be the same.[3] As the middle one third is filled principally by the nose, it becomes more prominent and the lower one third needs to be balanced with it. Developmentally, the nose and the maxilla are related together and taken as a single entity. The forward growths of the cartilages of the external nose have a tendency to bring the maxilla along with it, consequently inducing jaw growth.[4] Hence, the nose should be balanced vertically and laterally in its prominence.

The ideal nasal proportion requires a straight nasal dorsum with the dorsal cartilage and nasal tip cartilage above the nasal tip, forming the supra-tip break, and the alar rims 1–2 mm superior to the columella in the lateral view.[5–7] The ideal nose is in harmony with other skeletal features. However, this may not always be aesthetically in accordance with underlying jaw growth discrepancies, among different races and ethnicities, and between the two genders.

The nose, combined with the lips and chin influences the overall facial harmony.[8] Collectively, they form part of the soft tissue analysis given by Ricketts and Steiner, which measures the prominence of the lips in relation to the nose and chin.[9] The form of the nose and its inclination has an impact on influencing the measurements recorded. The decision to treat orthodontic patients by extraction or non-extraction method and skeletal aesthetic surgeries has an impact of either improving or deteriorating nasal profiles. The aim of this investigation was to assess the nasal profiles in sagittal and vertical skeletal patterns and to assess gender dimorphism in a sample of Pakistani adults.

MATERIAL AND METHODS

A cross-sectional analytical study was conducted using data from pre-treatment orthodontic records of patients who visited the orthodontic clinic, from July to August 2010. The inclusion criteria were subjects of Pakistani origin, aged between 18–40 years and having no prior history of orthodontic treatment. Patients having cranio-skeletal syndromes, anomalies and skeletal asymmetries were excluded.

The sample was divided into three vertical groups namely, normo-divergent, hypo-divergent and hyper-divergent, and two sagittal groups namely, skeletal Class I and skeletal Class II. The vertical pattern was measured using the angle formed between the anterior cranial base plane (S-N) and the mandibular plane (Go-Gn). The plane S-N was constructed between the midpoint of the sella turcica (S) and the point nasion (N). The mandibular plane was constructed between the points gonion (Go) and gnathion (Gn). The values in the range of 32°±4° were taken for normodivergent group, values less than 26° were taken for hypo-divergent group, and values greater than 38° were taken for hyper-divergent group, respectively (Figure-1). ANB angle was used to group the skeletal Class I and Class II (ANB=0°–4° and ANB >4° respectively) (Figure-2). Pre-treatment lateral cephalograms were traced manually on acetate paper after by the principal investigator after locating the anatomical landmarks (Figure-3), 12 measurements of the nasal profile were drawn and recorded (Figure-4).

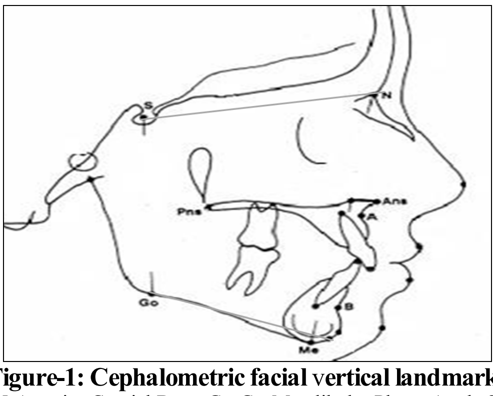


Figure-1: Cephalometric facial vertical landmarks
S-N-Anterior Cranial Base, Go-Gn-Mandibular Plane, Angle SN-Go-Gn-32°±4° Normodivergent, Angle SN- Go-Gn-26° Hypodivergent, Angle SN-Go-Gn-38° Hyperdivergent

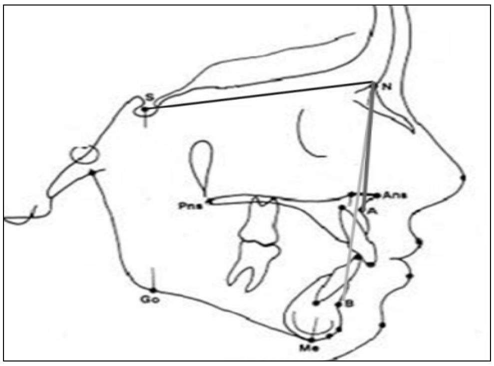


Figure-2: Cephalometric facial horizontal landmarks
S-N-Anterior Cranial Base, Angle SNA-82±2°, Angle SNB-80°±2°, Angle ANB-2°±2°

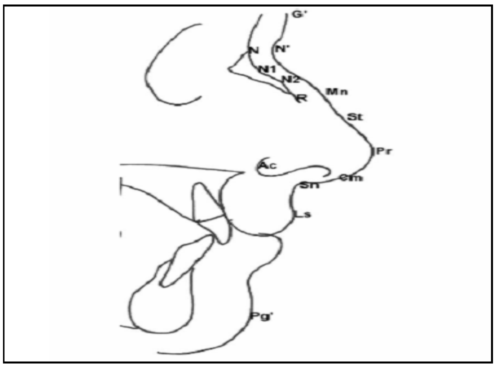
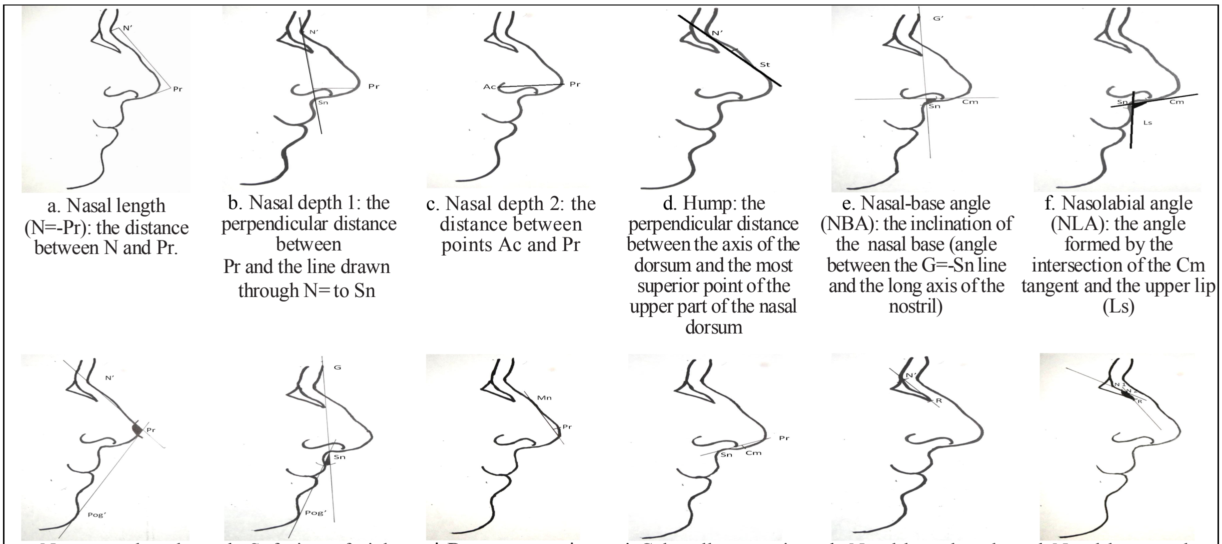


Figure-3: Cephalometric anatomical nasal landmarks
Glabella (G=): the most prominent point of the frontal bone, **Soft-tissue nasion (N=):** the point of greatest concavity in the midline between the forehead and the nose, **Midnasale (Mn):** the halfway point on nasal length (N=-Pr) that divides the dorsum into upper and lower dorsum, **Supratip (St):** the point constructed between midnasal and pronasal on the lower third of the nasal dorsum, **Nasion (N):** the intersection of the frontal and nasal bones, **N1:** the most concave point of the nasal bone, **N2:** the most convex point of the nasal bone, **Rhinion (R):** the most anterior and inferior point on the tip of the nasal bone, **Pronasale (Pr):** the tip of nose (nasal tip), **Columella (Cm):** the most convex point on the columellar-lobular junction, **Subnasale (Sn):** the point at which the columella merges with the upper lip in the midsagittal plane, **Alar curvature point (Ac):** the most convex point on the nasal alar curvature, **Labrale superior (Ls):** the point indicating the mucocutanous border of the upper lip, **Soft-tissue pogonion (Pg=):** the most anterior point on the chin in the midsagittal plane.

The study sample consisted of a total of 119 subjects (38 males and 81 females) with 62 subjects in normo-divergent, 56 subjects in 27 hypo-divergent, and 30 subjects in hyper-divergent group. The skeletal Class I comprised 56 subjects, 55 subjects in Skeletal Class II and, 8 subjects in Skeletal Class III.

The data were analysed using the SPSS-17.0). The frequencies of gender, sagittal and vertical groups were generated. Means and standard deviations for the three vertical and the three sagittal groups were compared using One way ANOVA. Independent sample *t*-test was used to assess the gender dimorphism and $p<0.05$ was considered to be statistically significant.

To rule out measurement error, 20 lateral cephalograms were re-evaluated after one week by the principal investigator. Paired sample *t*-test was used to determine the measurement for nasal dimensions and sagittal and vertical skeletal patterns. The results showed no significant differences between the two sets of measurements.



a. Nasal length (N=-Pr): the distance between N and Pr.

b. Nasal depth 1: the perpendicular distance between Pr and the line drawn through N= to Sn

c. Nasal depth 2: the distance between points Ac and Pr

d. Hump: the perpendicular distance between the axis of the dorsum and the most superior point of the upper part of the nasal dorsum

e. Nasal-base angle (NBA): the inclination of the nasal base (angle between the G=-Sn line and the long axis of the nostril)

f. Nasolabial angle (NLA): the angle formed by the intersection of the Cm tangent and the upper lip (Ls)

g. Nasomental angle (NMA): the angle constructed by the axis of the dorsum and the Pr-to-Pg line

h. Soft-tissue facial convexity (SFC): the angle between the G-Sn line and the Sn- Pg line

i. Dorsum convexity (Dconv): the perpendicular distance from the most convex point of the lower nasal dorsum to the Mn-Pr line

j. Columella convexity (Cconv): the perpendicular distance from the most convex point of columella to the line drawn from Pr to Sn

k. Nasal-bone length (NboneL): the distance from N to R.

l. Nasal-bone angle (NboneA): the posterior angle formed between the N1-N2 line and the N2-R line

Figure-4: Cephalometric nasal landmarks

RESULTS

The mean age of the three vertical groups, three sagittal and the males and females was determined using one way ANOVA and the independent sample *t*-test, with level of significance of ≤0.05 as statistically significant. The mean age for the normo-divergent group was 24.47±6.34 years, hypo-divergent, 24.70±6.30 years, and, for the hyper-divergent, 25.28±9.15 years. The mean age of the subjects in skeletal Class I is 25.38±7.54 years, for skeletal Class II, 24.61±6.86 years and, for skeletal Class III, 20.9±4.02. The mean age of males is 24.77±7.82 years, and for females it is 24.70±6.76 years.

Table-1 shows the means and the standard deviations for the vertical groups. Statistically significant differences were observed for nasal depth 2 and naso-labial angle for nasal measurements.

Table-2 shows the means and standard deviations for the sagittal groups. Statistically significant differences were found for naso-mental angle, soft tissue convexity and lower dorsum convexity.

Table-3 shows the means and standard deviations for the males and females in the group. Statistically significant differences were found for nasal length, nasal depth according to sub-nasale (nasal depth 1), nasal depth according to alar curvature (nasal depth 2), nasal hump, columella convexity and nasal bone length.

Table-1: Means and standard deviations for the vertical group (n=119)

	Normodivergent	Hypodivergent	Hyperdivergent	*p*
Nasal length	52.03±4.28	51.74±4.85	53.30±5.49	0.31
Nasal depth 1	17.40±2.20	18.00±2.02	18.00±2.45	0.49
Nasal depth 2	29.33±2.32	29.33±3.44	31.37±3.36	0.03
Hump	0.45±1.24	0.20±0.87	0.56±1.09	0.36
Naso labial angle	101.53±10.50	91.92±23.46	101.64±11.66	0.01
Nasal base angle	102.63±13.63	100.85±13.88	99.54±12.80	0.57
Naso mental angle	126.56±7.28	124.22±0.58	126.54±11.62	0.59
Soft tissue convexity	16.63±7.46	17.81±10.74	19.53±9.75	0.36
Dorsum convexity	2.43±0.81	2.22±0.80	2.24±0.71	0.47
Columella convexity	2.76±0.72	2.77±0.89	2.87±0.99	0.83
Nasal bone length	26.40±3.55	25.07±3.16	26.56±3.10	0.12
Nasal bone angle	165.37±13.49	167.07±8.62	167.00±9.87	0.77

Table-2: Means and standard deviations for the sagittal group (n=119, One-way ANOVA)

	Skeletal Class I	Skeletal Class II	Skeletal Class III	*p*
Nasal Length	53.30±5.54	51.83±4.53	53.37±5.12	0.28
Nasal Depth 1	17.96±2.47	17.69±2.02	18.12±3.97	0.79
Nasal Depth 2	30.87±3.55	29.89±3.01	30.50±3.07	0.29
Hump	0.40±1.28	0.48±0.85	0.62±1.15	0.83
Nasolabial Angle	99.23±13.99	100.63±16.58	92.25±15.35	0.35
Nasal Base Angle	99.25±12.49	101.81±14.48	102.00±8.45	0.56
Nasomental Angle	128.33±10.95	122.14±8.56	136.50±5.80	0.00
Soft tissue facial convexity	16.75±10.01	21.87±7.33	6.25±5.28	0.00
Lower dorsum convexity	2.35±0.67	2.30±0.81	1.62±0.74	0.03
Columella convexity	2.87±1.06	2.74±0.69	3.00±1.06	0.64
Nasal bone length	26.44±3.05	25.72±3.47	27.50±3.02	0.25
Nasal bone angle	167.57±8.50	164.96±12.61	171.12±6.22	0.19

Table-3: Means and standard deviations for males and females (n=119, Independent sample *t*-test)

	Male	Female	*p*
Nasal Length	55.52±4.88	51.27±4.60	0.00
Nasal Depth 1	18.89±2.69	17.35±2.06	0.00
Nasal Depth 2	32.47±3.19	29.41±2.87	0.00
Nasal Hump	0.82±1.00	0.27±1.09	0.01
Nasolabial Angle	100.55±14.52	98.87±15.76	0.58
Nasal Base angle	98.71±14.51	101.51±12.55	0.28
Nasomental Angle	124.71±9.85	126.64±10.67	0.34
Soft tissue convexity	18.73±10.54	18.25±9.00	0.79
Dorsum Convexity	2.26±0.72	2.29±0.78	0.82
Columella Convexity	3.10±1.00	2.69±0.83	0.02
Nasal Bone Length	27.21±2.79	25.70±3.37	0.01
Nasal Bone Angle	167.16±9.07	166.37±11.21	0.70

DISCUSSION

Limited studies have been conducted on nasal profile. The clinical impact on skeletal profile and influence in cephalometric soft tissue skeletal values cannot be denied. The results of this study showed that there is a significant difference between skeletal Class I and Class II for nasal base angle, naso-mental angle and soft tissue convexity. Study conducted by Gulsen *et al*[10] on Anatolian Turkish adults showed similar results. However, they found a statistically significant difference for the naso-labial angle in the sagittal group.

The study conducted by Genecov *et al*[11] found nasal bone projection and dorsal hump to be most commonly found in Skeletal Class II groups which is in disparity with the results of the present study. A study conducted by Robison *et al*[12] found straight noses in relation to straight skeletal profile and convex noses in association with convex profiles. This study found more upward inclined noses in skeletal Class II patients.

The values of this study when compared with other studies for gender dimorphism also showed variable results. Gulsen *et al*[10] conducted a study on Anatolian Turkish adults and found statistically significant differences between the two genders for nasal length, nasal depth 1 and 2, nasal hump, soft tissue and columella convexity. Although the present study nearly concurs with the results, however, it also established that males have increased nasal bone lengths, and that there is no significant difference between males and females for soft tissue convexities. A study conducted by Hwang *et al*[13] on Korean and European-American adults found insignificant differences between males and females for naso-labial angle. This is in agreement with the current study.

A study conducted by Milosevic *et al*[14] on Croatian adults compared skeletal profile among the adult males and females. Their results showed that males have slightly greater nasal prominence as compared with females. This is contrast with the present study which found insignificant difference between the two groups for nasal projection. Their study established that universal standard of skeletal aesthetic was not applicable for diverse populations and that such differences should taken into consideration for diagnosis and treatment planning for different racial groups, along with the patient's individual characteristics.

Scavone *et al*[15] conducted a study on white Brazilian adults concluded that women have a smaller nasal base projection and a more obtuse naso-labial angle. Although the present study found women to have larger nasal base projections and men to have a more obtuse naso-labial angle than females, overall there was an insignificant difference between the two genders for these measurements.

Fernandez *et al*[16] found the male nose to be more prominent than the female nose. This is in agreement with Enlow's[4] statement of the male nose being proportionately larger, more protrusive and longer. It has a more pointed tip and has tendency to be turned down with flaring nostrils while female noses have a tendency to be tipped upwards. The present study found that males have longer and deeper noses with long nasal bones and those females have more upward inclined prominent noses with a convex skeletal profile.

A study conducted by Marsan *et al*[17] on Skeletal Class III Turkish female patients who were treated with bilateral sagittal split osteotomy and Le Fort I advancement with maxillary impaction. They found that the increase in naso-labial angle was correlated with the decrease in lower anterior facial height. The present study, however found that increase in naso-labial angle is correlated with increase with vertical facial height.

Based on the present study, it is suggested that the nasal profile should be taken into consideration while diagnosing and planning treatment for patients as significant differences were seen in the male and female sample and for variations in sagittal and vertical facial patterns. The clinical significance of this research is to emphasize the importance of total skeletal harmony (especially nasal shape) during orthodontic diagnosis and treatment planning.

CONCLUSIONS

- Skeletal Class I, Class II and Class III have different nasal profiles due to differences in naso-mental angle, soft tissue convexity and lower dorsum convexity.
- Males and females have significantly different nasal profiles due to differences in nasal length, nasal depth, nasal hump, columella convexity and nasal bone length.
- Hypodivergent, hyperdivergent and normodivergent vertical patterns have different nasal profiles due to differences in nasal depth 2 and nasolabial angle.

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