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Original Article

Evaluation of Nasal and Soft Tissue Angular Measurements Across Class I, Class II, and Class III Orthodontic Patients: A Cross-Sectional Cephalometric Study

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Abstract

Background: Facial aesthetics is a fundamental component of orthodontic diagnosis and treatment planning, with increasing emphasis on soft tissue harmony rather than dental alignment alone. Angular soft tissue measurements of the nose, lips, and chin play a pivotal role in evaluating sagittal facial balance. Given the influence of ethnicity on facial morphology, population-specific reference values are essential to guide clinical decision-making.

Objective: To evaluate nasal and soft tissue angular measurements among Class I, Class II, and Class III orthodontic patients and to assess potential gender-based differences within a Pakistani population.

Methodology: This cross-sectional study was conducted at the Department of Orthodontics, Saidu College of Dentistry, Swat, from September 2024 to February 2025. A total of 109 adult patients with pre-treatment lateral cephalometric radiographs were included. Participants were classified into sagittal skeletal groups using ANB angle values. Five soft tissue angles nasolabial, nasomental, labiomental, chin-throat, and lip-chin-throat were manually traced and measured by a single calibrated examiner.

Results: Mean values of all evaluated soft tissue angles were generally within accepted aesthetic ranges. Class II subjects demonstrated higher angular values, indicative of a more convex soft tissue profile, while Class III subjects exhibited comparatively lower values consistent with straighter or mildly concave profiles. A statistically significant difference was observed only for the nasolabial angle across sagittal skeletal classes ($p = 0.036$). No significant gender-based differences were identified for any angular measurement.

Conclusion: Soft tissue angular measurements vary according to sagittal skeletal classification but are not influenced by gender in this population. The nasolabial angle emerged as a key diagnostic parameter, underscoring the importance of incorporating comprehensive soft tissue evaluation into orthodontic treatment planning.

Keywords: Cephalometry, Facial Aesthetics, Nasolabial Angle, Orthodontic Diagnosis.

Introduction

Cosmetic and aesthetic treatments have gained increasing popularity in recent years, with the face being the most prominent and immediately perceived feature. Facial attractiveness is inherently subjective and influenced by multiple factors, including ethnicity, age, gender, cultural background, and individual identity. Advancements in technology and media exposure have heightened public awareness regarding facial aesthetics, leading to increased demand for orthodontic treatment not only for functional correction but also for improvement in facial appearance and self-esteem [1–3].

Traditionally, orthodontic diagnosis emphasized dental alignment and skeletal relationships; however, contemporary orthodontics has shifted toward a soft tissue-driven treatment paradigm. Optimal management of soft tissues has long been recognized as a cornerstone of clinical orthodontics, as facial balance and harmony ultimately determine treatment success from the patient's perspective [1,2].

An ideal facial profile is often described using proportional concepts, with the face divided into vertical thirds and horizontal fifths. The nose, occupying the central facial third, plays a dominant role in overall facial harmony and aesthetic perception [4].

Among various soft tissue parameters, angular measurements of the nasal, labial, and chin regions are particularly valuable in assessing anteroposterior facial relationships. These angles reflect both underlying skeletal architecture and the overlying soft tissue envelope, making them critical indicators of sagittal discrepancies [5–7]. Soft tissue angular analysis allows clinicians to anticipate profile changes, guide extraction or camouflage decisions, and improve long-term aesthetic outcomes.

The nasolabial angle (NLA), formed by the intersection of the columella of the nose and the upper lip, is one of the most frequently evaluated parameters in orthodontic diagnosis. Its normal range is reported to be approximately 90°–110°, and it is influenced by nasal tip inclination, columellar length, upper lip thickness, and maxillary incisor position [8,9].

Alterations in this angle can significantly impact facial aesthetics and treatment planning, particularly in patients with sagittal skeletal discrepancies.

The nasomental angle (NMA) reflects facial convexity by assessing the relationship between the nasal dorsum and the soft tissue pogonion, with normal values reported between 120° and 132° [10,11]. Similarly, the labiomental angle (LMA) provides insight into lower lip and chin morphology and is sensitive to mandibular position and incisor inclination, with ideal values around 120° ± 10° [12,13]. Additional angles such as the chin-throat angle and lip-chin-throat angle describe lower facial and cervicomental contour and contribute to overall profile harmony [14].

Although numerous studies have evaluated soft tissue angular measurements, most available data are derived from Caucasian or non-South Asian populations. Existing literature suggests that soft tissue norms vary significantly among ethnic groups, reinforcing the need for population-specific reference values [15–17].

Furthermore, the influence of sagittal skeletal classification and gender on these angular measurements remains inconsistent across studies, particularly within Pakistani populations [18–23].

Therefore, the present study aimed to evaluate nasal and soft tissue angular measurements including nasolabial, nasomental, labiomental, chin-throat, and lip-chin-throat angles across Class I, Class II, and Class III orthodontic patients visiting Saidu College of Dentistry, Swat.

Additionally, the study sought to assess potential gender-based differences, contributing population-specific data to enhance orthodontic diagnosis and individualized treatment planning.

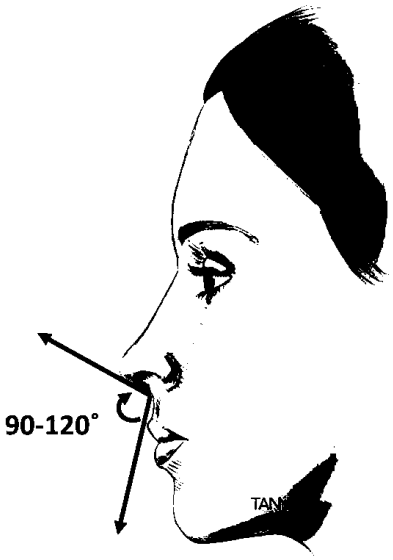


Figure 1: Naso-labial Angle

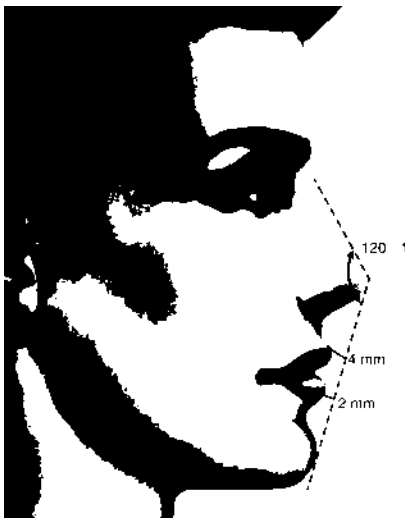


Figure 2: Naso-labial Angle

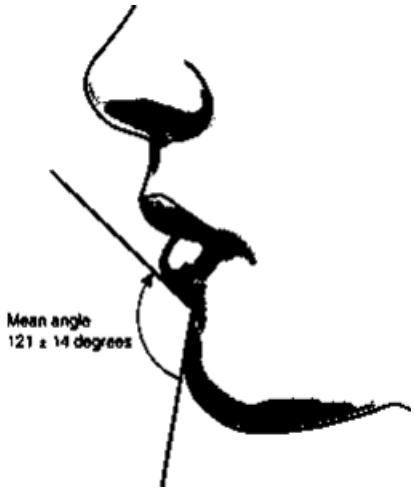


Figure 3: Labio-Mental Angle



Figure 4: Chin-Throat Angle

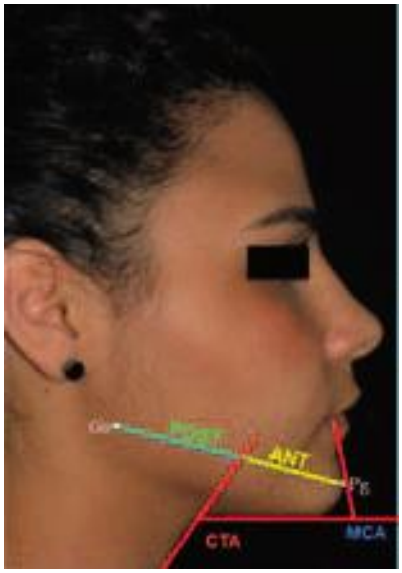


Figure 5: Lip-Chin-Throat

Methodology

Study Design

This study employed a descriptive cross-sectional design to evaluate nasal and other soft tissue angular measurements among orthodontic patients with different sagittal skeletal relationships. The cross-sectional approach was selected as it allows comparison of soft tissue profile characteristics across skeletal Classes I, II, and III at a single point in time, without the influence of treatment-related changes.

Ethics

Ethical approval for the study was obtained from the Institutional Review Board of Saidu College of Dentistry, Swat. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

All patient records and radiographs were anonymized prior to analysis to ensure confidentiality, and only pre-treatment diagnostic records routinely taken for orthodontic purposes were used.

Setting
The study was conducted in the Department of Orthodontics, Saidu College of Dentistry, Swat, Pakistan, over a six-month period from September 2024 to February 2025. The institution serves as a tertiary care teaching hospital and receives a diverse orthodontic patient population from the region, making it suitable for population-based soft tissue analysis.

Participants
Participants were selected using a convenience consecutive sampling technique from patients reporting to the orthodontic department during the study period. Inclusion criteria comprised adult patients with complete permanent dentition (28 teeth excluding third molars), availability of high-quality pre-treatment lateral cephalometric radiographs, and no prior orthodontic treatment. Patients were excluded if they had craniofacial syndromes, congenital anomalies, facial trauma, skeletal asymmetries, deviated nasal septum, mouth breathing habits, or any condition that could alter normal soft tissue morphology.

Variables
The primary outcome variables were five soft tissue angular measurements: nasolabial angle, nasomental angle, labiomental angle, chin-throat angle, and lip-chin-throat angle. The primary explanatory variable was sagittal skeletal classification (Class I, II, or III), determined using the ANB angle. Gender and age were considered secondary variables for subgroup comparisons and potential confounding assessment.

Data Sources/Measurement
Pre-treatment lateral cephalometric radiographs were retrieved from departmental records and used as the primary data source. Sagittal skeletal classification was determined based on ANB angle values, with Class I defined as 2°–4°, Class II as >4°, and Class III as ≤0°. All radiographs were manually traced by a single calibrated examiner under standardized conditions to ensure measurement consistency. Angular measurements were recorded using established cephalometric landmarks and reference lines.

Bias
To minimize observer bias, all tracings and measurements were performed by a single trained examiner following a standardized protocol. Intra-examiner reliability was assessed by retracing 20 randomly selected radiographs after a two-week interval. High intraclass correlation coefficients (ICC range: 0.88–0.96) confirmed excellent measurement reproducibility. Selection bias related to convenience sampling is acknowledged and addressed in the study limitations.

Study Size
Sample size estimation was performed using OpenEpi software with a confidence level of 95% and statistical power of 80%. Based on previously reported mean nasolabial angle values across skeletal classes, a minimum of 36–40 subjects per group was required. Accordingly, a total sample size of 109 participants was included to ensure adequate power for intergroup comparisons.

Quantitative Variables
All angular measurements were treated as continuous quantitative variables and expressed in degrees. Age was recorded in years and summarized as mean ± standard deviation. Skeletal classification was treated as a categorical variable for comparative analysis.

Statistical Methods
Data analysis was conducted using SPSS version 25. Descriptive statistics were calculated for all variables. One-way analysis of variance (ANOVA) was used to compare soft tissue angular measurements across sagittal skeletal classes, followed by post-hoc Tukey tests where applicable. Independent sample t-tests were employed to assess gender differences. Statistical significance was set at $p < 0.05$ for all analyses.

Results

Participants
A total of 109 orthodontic patients were included in the final analysis. Of these, 50 (45.9%) were male and 59 (54.1%) were female. Based on sagittal skeletal classification using the ANB angle, 39 participants (35.8%) were categorized as Class I, 43 (39.4%) as Class II, and 27 (24.8%) as Class III (Table 03). The overall age of participants ranged from 16 to 35 years, with a mean age of 22.5 ± 4.4 years. Age distribution was comparable across the three skeletal groups, minimizing the likelihood of age acting as a confounding factor in the analysis.

Descriptive Data
Descriptive analysis of soft tissue angular measurements demonstrated that the overall mean values of all five assessed angles generally fell within or close to established aesthetic norms. The mean nasolabial angle was 100.5° ± 10.1°, the nasomental angle measured 122.6° ± 8.5°, and the labiomental angle averaged 112.5° ± 13.2°. The chin-throat angle and lip-chin-throat angle showed mean values of 122.9° ± 15.8° and 115.8° ± 15.6°, respectively (Table 01). While most parameters remained within commonly accepted ranges, the chin-throat and lip-chin-throat angles tended to be slightly higher, suggesting population-specific

soft tissue characteristics in this Pakistani cohort. Gender-wise descriptive comparison revealed minimal variation between males and females across all angular measurements. Mean values for males and females were closely comparable, indicating overall similarity in soft tissue profile morphology between genders (Table 02).

Outcome Data

Inferential analysis using independent sample t-tests demonstrated no statistically significant gender-based differences for any of the evaluated soft tissue angles ($p > 0.05$ for all comparisons). Similarly, analysis of age distribution across skeletal classes revealed no significant differences, supporting the comparability of groups. One-way ANOVA was used to assess differences in angular measurements across sagittal skeletal classes. Among the five evaluated angles, only the nasolabial angle showed a statistically significant difference across Class I, Class II, and Class III groups ($p = 0.036$). The remaining angular measurements; nasomental, labiomental, chin-throat, and lip-chin-throat angles did not demonstrate statistically significant intergroup differences (Figure 06).

Main Results

Class II subjects consistently exhibited higher mean values for most soft tissue angular measurements, reflecting a more convex facial profile. The nasolabial angle was highest in Class II patients (103.9° ± 9.0°), compared with Class I (97.1° ± 10.1°) and Class III individuals (99.9° ± 10.3°) 9Table 03). This difference was statistically significant and highlights the influence of maxillary prominence on soft tissue profile convexity. Class III participants showed comparatively lower mean values for several angles, particularly the chin-throat and lip-chin-throat angles, consistent with straighter or mildly concave facial profiles. Class I individuals demonstrated intermediate values across all parameters, corresponding to balanced and harmonious facial aesthetics. Overall, the findings indicate that soft tissue angular measurements vary according to sagittal skeletal classification, with the nasolabial angle emerging as the most sensitive and diagnostically relevant parameter. Gender did not significantly influence any of the assessed soft tissue angles in this population.

Table 1: Soft Tissue Angular Variables.

Angle Variable	Normal Range (°)	Overall Mean ± SD
Nasolabial Angle (NLA)	90-110°	100.5° ± 10.1°
Nasomental Angle (NMA)	120-132°	122.6° ± 8.5°
Labiomental Angle (LMA)	100-130°	112.5° ± 13.2°
Chin-Throat Angle (CHTH)	90-120°	122.9° ± 15.8°
Lip-Chin-Throat Angle (LIPCHTH)	100-120°	115.8° ± 15.6°

Table 2: Gender Dimorphism.

Angle	Male (Mean ± SD) N= 50	Female (Mean ± SD) N=59	t-Statistic	p-Value
NLA	100.9 ± 9.7	99.8 ± 10.5	0.62	0.537
NMA	122.1 ± 8.4	123.4 ± 8.5	-0.85	0.398
LMA	112.5 ± 13.0	112.4 ± 13.9	0.05	0.961
CHTH	122.5 ± 15.0	124.1 ± 14.8	-0.54	0.590
LIPCHTH	115.0 ± 15.6	115.9 ± 14.7	-0.32	0.749

Table 3: Comparison Of Angular Measurements Across Sagittal Skeletal Classes (N=109)

Angle	Class I N = 39	Class II N = 43	Class III N = 27	F-Statistic	p-value
NLA	97.1° ± 10.1°	103.9° ± 9.0°	99.9° ± 10.3°	3.45	0.036
NMA	121.8° ± 7.9°	124.3° ± 7.6°	120.9° ± 11.0°	1.95	0.148
LMA	116.2° ± 15.5°	108.9° ± 13.0°	113.0° ± 9.7°	2.58	0.081
CHTH	124.3° ± 14.8°	126.2° ± 13.9°	115.6° ± 17.9°	2.23	0.112
LIPCHTH	114.5° ± 14.9°	118.8° ± 14.3°	112.8° ± 17.6°	0.92	0.401

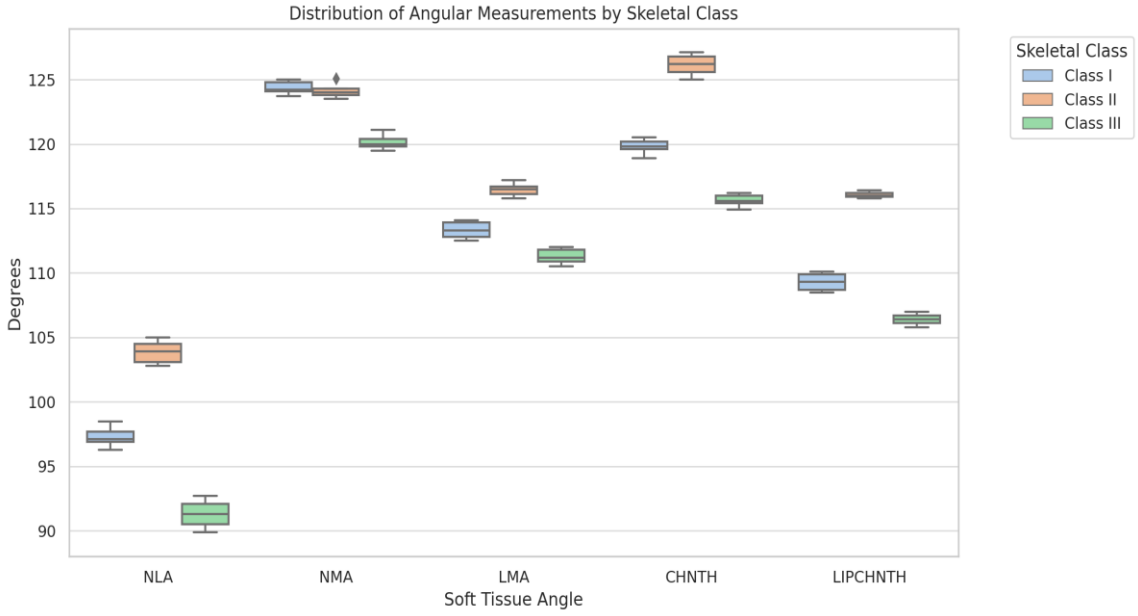


Figure 6: Distribution of Angular Measurement by Skeletal Class

Table 4: Age Distribution by Skeletal Class.

Skeletal Class	Number of Subjects (n)	Mean Age (years)	Age Range (years)
Class I	39	22.5 ± 4.3	17–32
Class II	43	23.1 ± 5.0	16–35
Class III	27	21.8 ± 3.7	17–31
Total	109	22.5 ± 4.4	16–35

Discussion

The present study evaluated nasal and soft tissue angular measurements in a Pakistani orthodontic population and examined their relationship with sagittal skeletal classification and gender. Overall, the mean values for the nasolabial, nasomental, labiomental, chin-throat, and lip-chin-throat angles were found to be largely within established aesthetic norms, highlighting generally balanced facial profiles among the studied subjects. These findings support the growing emphasis on soft tissue evaluation as a central component of orthodontic diagnosis and treatment planning [1,2].

The mean nasolabial angle (100.5° ± 10.1°) observed in this study closely aligns with values reported in Southeast Asian populations by Naini et al. and other regional studies, suggesting shared aesthetic characteristics within South Asian cohorts [15]. Similarly, Arshad et al. reported comparable nasolabial and labiomental angle values in Pakistani adults, reinforcing the consistency of these parameters within this population [16]. In contrast, studies conducted in East Asian populations have reported relatively more acute nasolabial angles, reflecting ethnic variations in nasal projection and lip morphology [17]. These inter-ethnic differences further underscore the importance of establishing population-specific soft tissue reference values for orthodontic diagnosis.

Gender-based analysis revealed no statistically significant differences in any of the evaluated soft tissue angles, indicating that gender did not exert a meaningful influence on facial soft tissue angular measurements in this sample. These findings are consistent with those of Anić-Milosević et al. and Hossain et al., who similarly reported negligible gender differences in adult soft tissue facial profiles [18,19]. However, some studies have demonstrated gender dimorphism in specific angles, particularly the nasolabial and labiomental angles, attributing these differences to variations in nasal base projection and lip thickness [20–22]. The absence of significant gender differences in the present study may reflect population-specific characteristics, sample composition, or age distribution, highlighting the need for cautious generalization across ethnic groups.

A key finding of this study was the variation in soft tissue angular measurements across sagittal skeletal

classifications. Class II subjects exhibited the highest mean values for several parameters, including the nasolabial, nasomental, and chin-throat angles, indicative of a more convex facial profile. These results are in agreement with previous studies that reported increased facial convexity and obtuse soft tissue angles in Class II malocclusions due to maxillary prominence or mandibular retrusion [24–26]. Conversely, Class III subjects demonstrated lower angular values, particularly in the chin-throat and lip-chin-throat angles, reflecting straighter or mildly concave facial profiles, as also observed in recent regional studies [24].

Among all evaluated parameters, the nasolabial angle was the only measurement that demonstrated a statistically significant difference across skeletal classes ($p = 0.036$). This finding reinforces the diagnostic relevance of the nasolabial angle as a sensitive indicator of sagittal discrepancies and maxillary incisor positioning [8,9,25]. The lack of statistically significant differences in other angles may be attributed to compensatory soft tissue adaptation, individual variability, or the influence of multiple anatomical factors shaping the facial profile [6,7].

Age distribution was relatively uniform across skeletal classes, minimizing its confounding effect on the results. This observation aligns with findings by Shastri et al., who reported minimal age-related variation in nasal morphology within young adult populations [27]. However, other studies have suggested that nasal and soft tissue morphology may continue to change with age, particularly beyond early adulthood [28]. Although the present study included post-pubertal individuals, subtle age-related changes cannot be entirely excluded and should be considered in future research designs.

From a clinical perspective, the findings of this study support the paradigm shift toward soft tissue-driven orthodontic diagnosis. Evaluating nasal and chin-related angular parameters allows clinicians to anticipate facial profile changes, refine treatment mechanics, and improve aesthetic outcomes [29,30]. Incorporating such measurements into routine assessment ensures that orthodontic treatment goals extend beyond dental alignment to achieving long-term facial harmony and patient satisfaction.

It is important to acknowledge that the use of convenience consecutive sampling and data from a single institution may introduce selection bias and limit generalizability. Nonetheless, the study provides valuable baseline data for a Pakistani population and lays the groundwork for future multicenter and longitudinal investigations.

Conclusion

Soft tissue angular measurements demonstrate systematic variation with sagittal skeletal classification in the Pakistani orthodontic population. Class II subjects exhibited higher mean angular values, reflecting a more convex facial profile, while Class III subjects showed lower values consistent with straighter or mildly concave profiles.Gender did not significantly influence nasal or soft tissue angular measurements in this cohort.The nasolabial angle emerged as the most diagnostically sensitive parameter, showing a statistically significant difference across skeletal classes. Incorporation of comprehensive soft tissue angular analysis is essential for accurate orthodontic diagnosis and individualized treatment planning, particularly when addressing facial aesthetics in population-specific contexts.

Authors' Contributions:

All authors meet the ICMJE criteria for authorship.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 6: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.

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