ORIGINAL RESEARCH

Mouth Breathing Habit and Their Effects on Dentofacial Growth in Children in the Age Range of 6–14 Years: A Cephalometric Study

Kritika Chowdhary[1], Gunjan Yadav[2], Amit Rai[3], Sonali Saha[4], Kavita Dhinsa[5], Anshul Sharma[6]

Abstract

Nasal breathing protects the upper airway and is responsible for adequate craniofacial development. It is believed that long-standing obstruction causes mouth breathing, which has a negative impact on the craniofacial complex.

Aim: The study aimed to verify the effects of mouth breathing on the dentofacial structure by employing cephalometric analysis.

Materials and methods: The present study was conducted on 68 patients (34 mouth-breathing group or study group and 34 nasal-breathing group or control group) aged 6–14 years. Study subjects were screened based on the inclusion and exclusion criteria. Clinical assessment of nasal function was done to select the mouth breathing patients and referred for ear, nose, and throat (ENT) clearance. Lateral cephalograms were taken for the study subjects, including both nasal and mouth breathers, over which selected landmarks were marked to evaluate linear, skeletal, and dental angular variables for comparison with cephalometric variables of a normal child.

Results: The mean values of facial height (N-Me, ANS-Me) and mandibular plane angle (SN-GoGn) were significantly higher for mouth breathers. The gonial angle (Ar-GoMe) for ages 6–14 years was significantly lower in the nasal breathing group.

Conclusion: The study led to the conclusion that all subjects with a history of mouth breathing showed an increase in facial height, gonial angle, and mandibular plane angle.

Clinical significance: Evaluating dentoskeletal changes in a patient with a mouth-breathing habit helps discern the importance of early identification and interception at an early age, thereby ensuring a functional environment adequate for physiological growth and dentofacial esthetics.

Keywords: Cephalometrics, Malocclusion, Mouth breathing.

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Introduction

The primary functions of the oral cavity are well synchronized; any disturbance in its functioning causes unusual growth and development of the craniofacial complex's bony and soft tissue structures.[1]

Most healthy individuals primarily breathe through their nose rather than their mouth. Any obstruction in the nasal or nasopharyngeal pathways may convert this normal breathing pattern to oral breathing, compensating for reduced airflow through the nose and ensuring sufficient respiration.[2]

Oral breathing is a respiratory disorder that impacts a significant portion of children, adolescents, and adults in the general population. It can cause both topical and systemic pathological effects.[3]

A series of signs and symptoms that may be partially or completely present in individuals who, for various reasons, shift from nasal breathing to an oral or oronasal breathing pattern for over 6 months is characterized as mouth breathing syndrome.[4]

The harmful habit of oral breathing causes several morphological and functional changes in the stomatognathic system and the entire body. These changes include alterations in speech, posture, the shape of the dental arches, the positioning of the teeth, and the individual's dentofacial pattern.

One of the most valuable services in interceptive orthodontics is addressing oral habits during their primary and early transitional periods, thus allowing adequately controlled growth and development of occlusion. Pedodontists are at a beneficial advantage as they can observe the child while the habit is forming, giving them the opportunity to intervene before the harmful effects of the habit become apparent.[5]

Early intervention in these patients encourages favorable mandibular growth, leading to an esthetically pleasing facial profile.

[1–6]Department of Pedodontics and Preventive Dentistry, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh, India

Corresponding Author: Gunjan Yadav, Department of Pedodontics and Preventive Dentistry, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh, India, Phone: +91 9454109142, e-mail: gunjanyadav@rediffmail.com

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Aim

The study aimed to verify the effect of mouth breathing on the dentofacial structure by employing cephalometric analysis.

Objectives

- To assess angular skeletal parameters in a mouth breather using a standard lateral cephalogram.
- To assess linear skeletal parameters in a mouth breather using a standard lateral cephalogram.
- To assess angular dental parameters in a mouth breather using a standard lateral cephalogram.
- To assess linear dental parameters in a mouth breather using a standard lateral cephalogram.
- Comparison of angular skeletal parameters in the nasal breather and mouth breather using a standard lateral cephalogram.
- Comparison of linear skeletal parameters in the nasal breather and mouth breather using a standard lateral cephalogram.
- Comparison of angular dental parameters in the nasal breather and mouth breather using a standard lateral cephalogram.
- Comparison of linear dental parameter changes in the nasal and mouth breather using a standard lateral cephalogram.

Materials and Methods

The research was carried out after ethical clearance from the Institutional Ethics Committee and written informed consent from the parents or guardians of the selected participants. A pilot study was conducted in the same department to check the study design, addressing any potential constraints for the main study.

Sample size estimation was done using G*Power software (version 3.0). Sample size was estimated for *t*-test, and the means—difference between two independent means was chosen.

A minimum total sample size of 68 (34 in each group, i.e., mouth-breathing group and nasal-breathing group) was found to be sufficient for an α of 0.05, power of 80%, and 0.7 as the effect size (assessed for mandibular plane angle).

Therefore, the present study was carried out on 68 healthy patients (34 in each group, i.e., mouth breathing or study group and nasal-breathing or control group) within the age range of 6–14 years with or without a history of mouth breathing habit.

Patients with a history of mouth breathing were assigned to the study group, while those without the habit were included in the control group.

Inclusion Criteria

- Children aged 6–14 years.
- Healthy patients with or without a history of mouth breathing.
- Parents who have given consent for participation.

Exclusion Criteria

Children having the following were not included in the study:

- History of orthodontic treatment.
- Children with craniofacial syndromes/congenital maxillofacial deformity.
- Birth injuries and cleft palate.
- Oral and nasal surgeries.
- Patients who have bone deformities in the craniofacial region.
- Muscular dystrophies.
- Mentally challenged children.
- Severe facial asymmetry.
- Children with other chronic diseases or syndromes.
- Systemic diseases affecting bone and general growth.
- History of thumb sucking or any other oral habit apart from mouth breathing.
- History of dental trauma.

Clinical Assessment of Nasal Function

Assessment involved testing the selected participants for nasal function in the pediatric clinic. They were asked to hold water in their mouth for 1 minute while breathing through their nose. Additionally, a mirror was used to check for fogging or condensation near both the nose and mouth. Clearance from the ear, nose, and throat (ENT) department was sought as part of this assessment.

Radiographic Assessment of Dentofacial Changes

All required radiation protection measures were implemented to minimize exposure for all subjects. Each subject was instructed to face a long mirror placed correctly in front of them. Radiographs were taken using the same cephalogram setup, with the Frankfort horizontal plane parallel to the floor and teeth in centric occlusion, using Fuji X-ray film (8 × 10″) with speed E. The exposure settings were 80 kVp, 40 mA for 2 seconds, with a standard film-to-tube distance of 165 cm, using the Planmeca OY 00880 (EC Proline, Helsinki, Finland).[1]

To ensure standardized cephalograms, all of them were uniformly oriented for each patient with consistent magnification. Tracings for the study were manually done by a single operator using a hard 3H pencil on a standard cellulose acetate tracing sheet measuring 8 × 10″ and 0.003″ thick. This process took place under standard illumination in a dark room; the lightbox area around the cephalogram was shielded to optimize landmark identification.

Angular measurements were manually taken using a protractor with a precision of 0.5°, while linear measurements were conducted using a metallic scale with 0.5 mm accuracy. Specific landmarks (Fig. 1) were identified and marked, and from these, various linear, skeletal, and dental angular measurements were taken. The measurements from cephalometric tracings of mouth breathers (Figs 2A to D) and nasal breathers (Figs 3A to D) were recorded for intergroup comparison of cephalometric variables.[6]

Cephalometric Landmarks Used in the Study

The parameters (dental linear, dental angular, and skeletal angular) that were used in the study (Fig. 1) for determining the dentofacial changes of both the groups (mouth breathing or study group and nasal breathing or control group) are given below.[7]

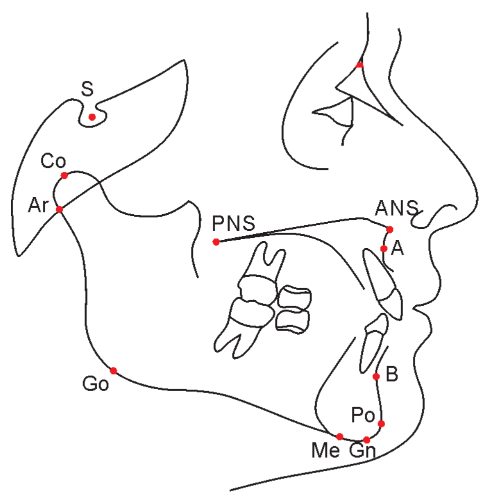


Fig. 1: Cephalometric landmarks used in the study

Measurement of Cephalometric Error

Error due to fatigue: Two cephalograms were analyzed on average per day to minimize errors due to investigator fatigue.

Intraobserver error: The assessment of intraobserver variability and reproducibility of landmark location and measurement errors was analyzed by retracing 10% randomly selected cephalograms after a gap of 15 days. The method error was calculated according to the Dahlberg formula:

$$S_D = \sqrt{\frac{\sum_{i=1}^{n} d_i^2}{2n}}$$

- d is the difference between the pairs of replicate measurements
- n is the number of cases
- S_D is the estimate of the random error.

Statistical Analysis

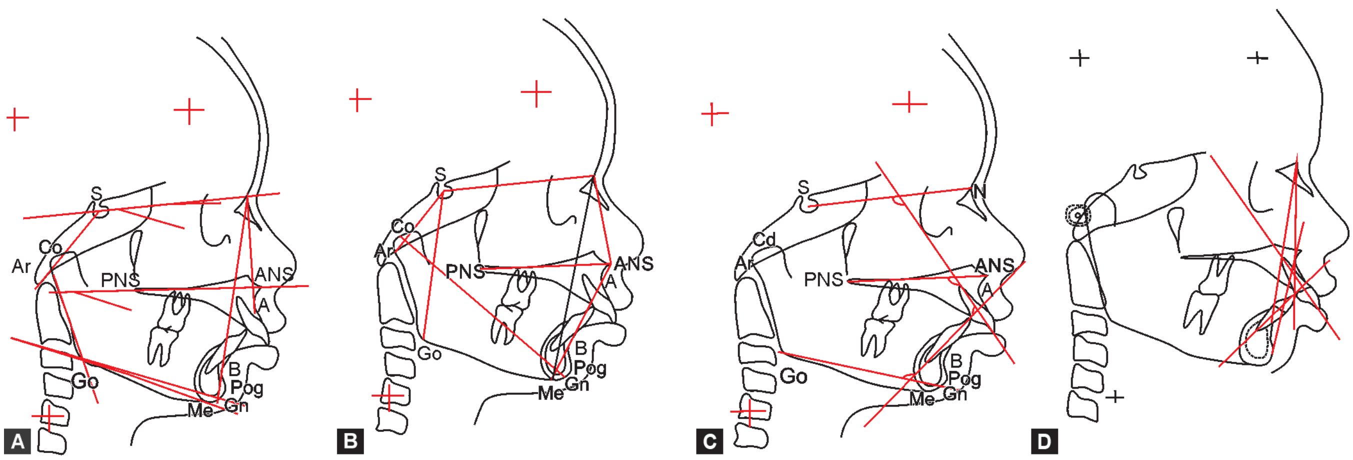
Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21. All cephalometric variables were summarized as means and standard deviations. Intergroup comparison of cephalometric variables was performed using an independent Student's *t*-test. The level of statistical significance was set at 0.05.

Observation and Results

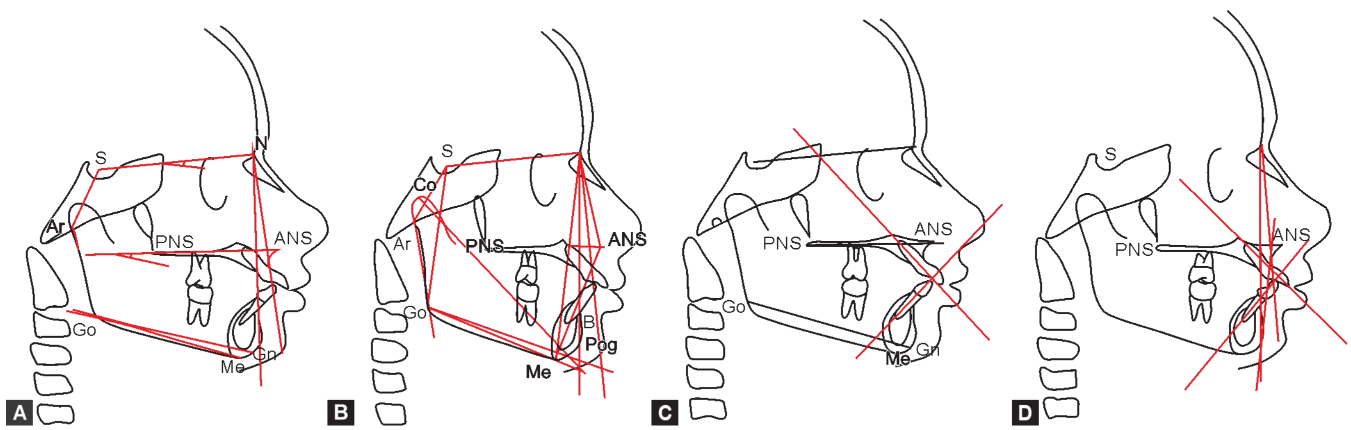
Lateral Cephalometric Analysis

Figure 4 shows that there was a significant increase in SNA (p-value of 0.001), ANB (p-value < 0.001), MnP-MxP (p-value < 0.001), N-S-Ar (p-value < 0.001), SN-GoGn (p-value < 0.007), and Ar-Go-Me (p-value < 0.001) among mouth breathers compared to healthy nasal breathers. SNB was found to be significantly reduced among mouth breathers (p-value < 0.001). Additionally, no significant change was found in the mean values of MxP-SNL (p-value < 0.345) between the two groups.

Figure 5 shows that the mean values of Co-Gn (p-value < 0.001), N-S (p-value < 0.001), S-Ar (p-value < 0.001), N-ANS (p-value < 0.001), ANS-Me (p-value < 0.001), and N-Me (p-value < 0.001) increased significantly in the mouth breathing group compared to the nasal breathing group. However, ANS-PNS (p-value < 0.001) and N-S (p-value < 0.001) were significantly reduced among the mouth breathing group on comparison with the nasal breathing group.



Figs 2A to D: Lateral cephalogram of a healthy mouth breathing patient showing various parameters used in the study: (A) Skeletal angular variables; (B) Skeletal linear variables; (C) Dental angular variables; (D) Dental linear variables



Figs 3A to D: Lateral cephalogram of a healthy nasal breathing patient showing various parameters used in the study: (A) Skeletal angular; (B) Skeletal linear; (C) Dental angular; (D) Dental linear

Figure 6 shows that there was an increase in the MXI-MNI, MNI-MNP, and MXI-SNL (*p*-value < 0.001) among the study group compared to the control group.

Figure 7 shows that there was a significant increase in UI-A-Pog, LI-A-Pog, UI-NA, and LI-NB (*p*-value < 0.001) in the mouth breathing group compared to the nasal breathing group.

Discussion

Respiration primarily occurs through the nose and is essential for vital bodily functions. The nasal cavity plays a crucial role in respiration by filtering, heating, and humidifying the air being inhaled. Nasal intake is critical for supplying properly cleaned air to the lungs. In children, mouth breathing indicates underdeveloped oral function, which negatively impacts the oral cavity, craniofacial morphology, and overall health. Oral breathing syndrome is characterized by a series of signs and symptoms that, for various reasons, lead to a shift from normal nasal breathing to an oral or oronasal pattern.[3,4]

Mouth breathing is a manifestation of abnormally developed oral function that has a negative impact not only on the oral cavity and craniofacial complex but also on general health conditions.[8]

The cephalometric tool aids in assessing the nasopharyngeal space, size of the adenoid, and skeletal patterns of patients by

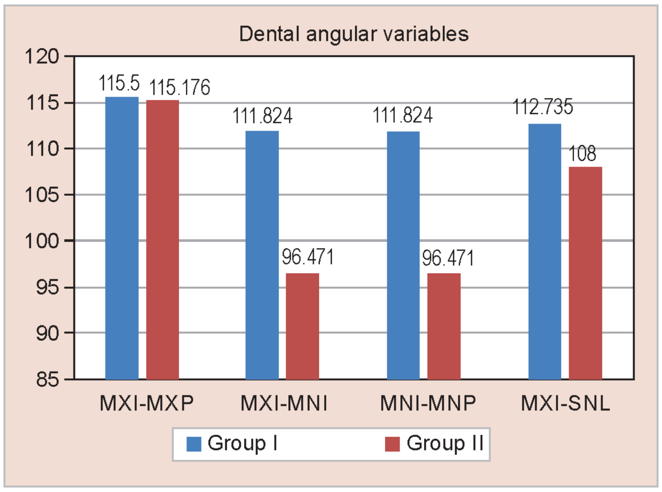


Fig. 6: Intergroup comparison of dental angular variables between the two groups

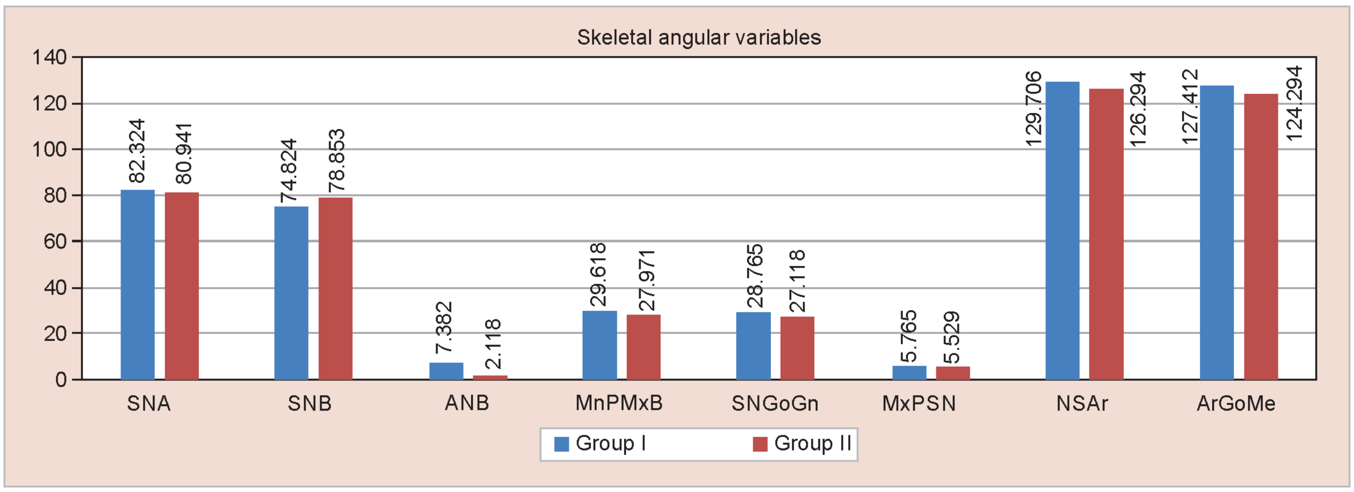


Fig. 4: Intergroup comparison of skeletal angular variables between the two groups

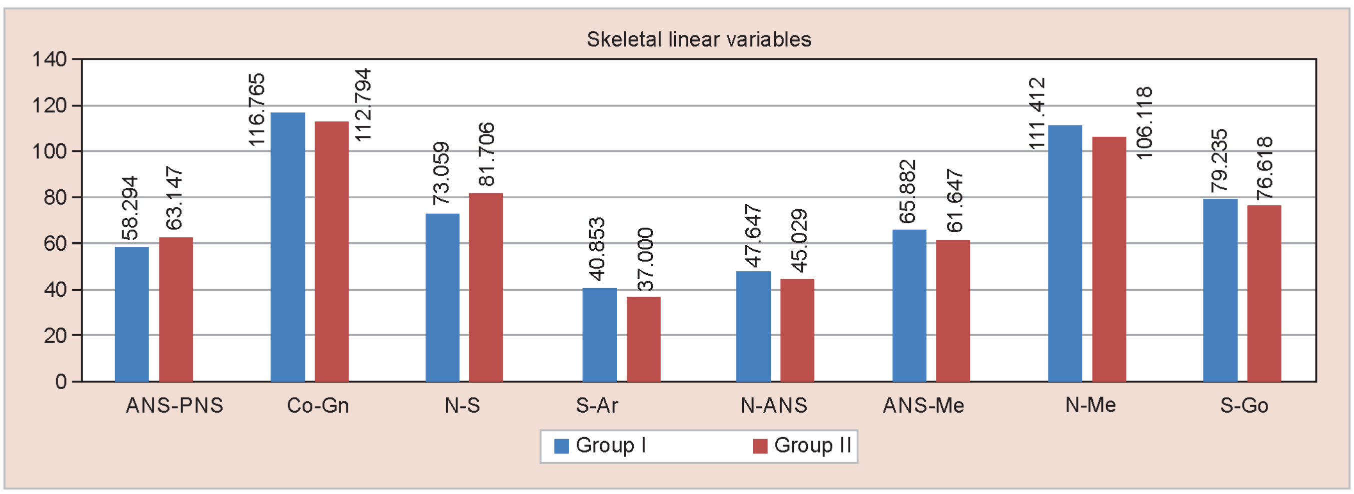


Fig. 5: Intergroup comparison of skeletal linear variables between the two groups

measuring various cephalometric angles.[9] Also, it is a useful tool in screening anatomical defects in patients with altered breathing pattern.

Evaluation of the anteroposterior positioning of the maxilla and mandible, inclination of occlusal and mandibular planes, positioning of anteriors, and measurement of the nasopharyngeal air spaces is crucial for diagnosing mouth breathing and obstructive sleep disorders.

Thus, in the current study, cephalometric analysis was employed to verify the effect of mouth breathing on the dentofacial structure.

The parameters used in the present study included skeletal angular (Table 1), skeletal linear (Table 2), dental angular (Table 3), and dental linear (Table 4) measurements to determine dentofacial changes in the landmarks of both groups. Safety measures were taken to minimize cephalometric errors, and their means were subjected to statistical analysis.

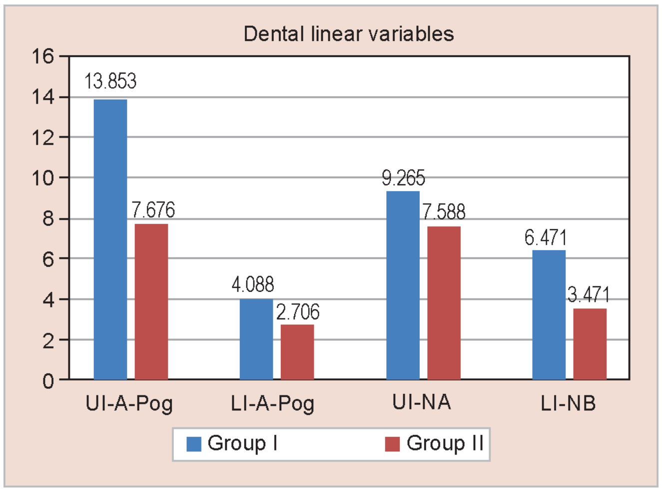


Fig. 7: Intergroup comparison of dental linear variables between the two groups

Table 1: Skeletal angular parameters[5]

SNA	The angle between SN to point A
SNB	The angle between SN to point B
ANB	The angle between point A-nasion-point B
(MnP-MxP) basal plane angle	The angle between gonion and menton and ANS to PNS
SN-GoGn	The angle between gonion and gnathion and SN
MxP-SN	The angle between ANS and PNS and SN
(N-S-Ar) saddle angle	The angle between SN to articulare
(Ar-Go-Me) gonial angle	The angle between the articulare gonion to menton

Table 2: Skeletal linear parameters

ANS-PNS	Maxillary length
Co-Gn	Mandibular length
N-S	Anterior cranial base length
S-Ar	Posterior cranial base length
N-ANS	Upper anterior facial height
ANS-Me	Lower anterior facial height
N-Me	Total anterior facial height
S-Go	Posterior facial height

The mean values of the skeletal angular variables SNA, ANB, MnP-MxP, N-S-Ar, SN-GoGn, and Ar-Go-Me were significantly increased among mouth breathers. However, SNB was found to be significantly reduced compared to healthy nasal breathers.

The results of this study for the skeletal angular variables were familiar with the studies done by Bakor et al.,[10] Mattar et al.,[11] and Vukicevic et al.[12]

Reduced SNB values were observed in the mouth breathers. It was familiar to findings by Pereira et al.[13] and Lysy et al.[14]

According to Bakor et al., there was an increase in the mandibular plane angle relative to the anterior cranial base (SN-GoGn) compared to nasal breathing patients.[10]

According to Mattar et al., mouth breathers have a steeper mandibular plane angle and gonial angle.[11] Vukicevic et al. found that the value of the maxillary prognathism angle (SNA) was greater in children who are mouth breathers, indicating mild retrognathism of the upper jaw.[12] Pereira et al. found that changes mostly seen in mouth breathers, compared with nasal breathers, included a hypoplastic maxilla and mandible, an increased gonial angle, and downward and backward mandibular rotation.[13] SNB angle was more posterior to the cranial base due to the forward and downward positioning of the tongue, which was even more pronounced when the posterior air space was filled with adenoid tissue. Consequently, it is hypothesized that altered breathing predisposes individuals to dental malocclusion due to the effect of positioning of the tongue and mandible, maintaining a downward and backward position during growth. Lysy et al. found that due to altered respiration patterns, there was an increase in the gonial angle, accompanied by increased facial height and mandibular plane angle.[14]

Mean values of the skeletal linear variables Co-Gn, S-Ar, N-ANS, ANS-Me, N-Me, and S-Go were significantly increased in the mouth breathing group, while ANS-PNS and N-S were notably reduced in the mouth breathing group compared to the nasal breathing group.

Our results on skeletal linear variables were consistent with the previous studies done by Lessa et al.,[15] Franco et al.[16] ANS-PNS in the current study was significantly greater in the nasal breathing group which was familiar to research done by Cuccia et al.,[17] and Agostinho et al.[18]

Lessa et al. found that there was an increase in lower anterior facial height (ANS-Me) and greater mandibular inclination with increased vertical growth in mouth breathers compared with the nasal breathing group.[15]

Table 3: Dental angular parameters

MXI-MXP	The angle between maxillary incisors and ANS to PNS
MXI-MNI	Interincisal angle
MNI-MNP	The angle between mandibular incisors and gonion to gnathion (mandibular plane)
MXI-SNL	The angle between maxillary incisors and SN

Table 4: Dental linear parameters

UI-A-Pog	Upper incisors to point A-pogonion
LI-A-Pog	Lower incisors to point A-pogonion
UI-NA	Upper incisors to nasion-point A
LI-NB	Lower incisors to nasion-point B

Franco et al. stated that the mouth breathing group is expected to have more backward mandibular rotation, increased lower anterior face height, and a steeper mandibular plane compared with the nasal breathing group.[16]

The impact of mouth breathing is seen in various aspects of development, including the face, orientation, functioning, and overall body development. Mouth breathing children often exhibit anterior open bite, increased overjet, posterior mandibular rotation, and narrowing of the maxilla.

As observed by Agostinho et al., children who exhibited oral breathing were found to be more skeletally vertical, consistent with previous studies indicating marked vertical growth due to narrowing of the airway space. This growth, along with the backward mandibular rotation, subsequently causes a reduced overbite in these subjects.[18] This difference was also found to be statistically remarkable in a study by Cuccia et al. (2008).[17]

The results of our study on the third variable, dental angular variables maxillary incisor to maxillary plane (MXI-MXP), maxillary incisor to mandibular incisor (MXI-MNI), mandibular incisor to mandibular plane (MNI-MNP), and maxillary incisor to sella-nasion line (MXI-SNL), showed that the mean values of MXI-MNI, MNI-MNP, and MXI-SNL were significantly increased in the mouth breathers compared to the nasal breathers.

The results of our study were familiar to research did previously by Faria et al.,[19] and Harari et al.[20] wherein, Faria et al. stated that the inclination of maxillary and mandibular incisors is controversial. In mouth breathers, the maxillary incisors tend to protrude, likely due to the interpositioning of a hypertonic lower lip between the upper and lower incisors, causing labial inclination of the upper incisors.

Harari et al. found that in mouth breathers, there is a significant backward and downward mandibular rotation, increased overjet, and a steeper mandibular plane angle.[20] However, Subtelny,[21] and Solow and Greve[22] stated retroclinated upper incisors in these subjects in relation to the S-N line and Koski et al. reported that the lower incisors presented retroclination in relation to the mandibular plane in patients with enlarged adenoid.[23]

The results of the current study on the fourth variable, dental linear variables UI-A-Pog, LI-A-Pog, UI-NA, and LI-NB, showed that the mean values of UI-A-Pog, LI-A-Pog, UI-NA, and LI-NB were significantly increased in the mouth breathing group compared to the nasal breathing group.

The results of this study were in support of studies done by Basheer et al.,[24] and Rangeeth and Rangeeth.[25]

Basheer et al. found that upper incisor proclination was significant in mouth breathers. According to them, mouth breathers showed significantly greater upper incisor proclination, incompetent lips, and convex facial profile.[24] Rangeeth et al. found that cephalometric analysis showed a remarkable increase in maxillary and mandibular incisors proclination, steeper mandibular plane angle lower anterior facial height and inter-labial distance in mouth breathing children.[25]

In the present study, it was found that the mouth breathing habit not only leads to changes in maxillary and mandibular growth but also affects cranial growth, indicating the adverse effects of the habit. To further identify changes related to these habits, variables such as the intensity, duration, and frequency of the habit need to be considered. However, due to the limited sample size in the study group, it wasn't possible to divide them into subgroups based on these variables. This opens paths for further research in this area.

Conclusion

Within the limitations of the study, evaluating dentoskeletal changes in mouth breathing patients will help discern the significance of early identification and intervention using definitive diagnostic aids. This approach secures a functional environment conducive to normal growth, thereby promoting occlusal harmony and dental-facial esthetics.

Orcid

Gunjan Yadav https://orcid.org/0000-0001-9495-9471
Amit Rai https://orcid.org/0000-0002-5270-0303
Sonali Saha https://orcid.org/0000-0001-5361-1698
Kavita Dhinsa https://orcid.org/0000-0002-3597-787X
Anshul Sharma https://orcid.org/0000-0003-3128-8126

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