Adenoidal nasopharyngeal ratio and its correlation with skeletal class II malocclusion in children: A cross-sectional study

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KEYWORDS

ABSTRACT

Introduction: The relationship between skeletal class II malocclusion and airway has gained significant interest in the field of orthodontics and is crucial for accurate diagnosis and treatment planning. Various etiologies contribute to airway obstruction, which may disrupt the breathing pattern and swallowing functions, affecting the development of the craniofacial complex and consequently resulting in the development of skeletal Class II malocclusion. Adenoid hypertrophy (AH) has been linked to cardiopulmonary complications, craniofacial growth disturbances and obstructive sleep apnea. Patients with AH often exhibit a characteristic adenoid face and mouth breathing pattern with a narrow constricted maxillary arch and retrognathic mandible. Adenoidal- nasopharyngeal ratio is a simple linear measurement obtained from lateral cephalograms that can reliably express adenoidal size and patency of the nasopharyngeal airway and give further insight into the etiology of development of class II malocclusion and correlation with the same.

Materials and methods: Sample of 40 individuals between 10-16 years of age was divided into two groups of 20 each based on their ANB angle, Group A comprised of individuals showing skeletal class I and group B showing skeletal class II malocclusion respectively. Lateral cephalograms were taken and AN ratio was assessed using the Fujioka et al method for both groups. AN ratios were correlated with skeletal class of malocclusion and values of both groups were compared.

Results: The AN ratio was found to considerably higher in individuals with skeletal class II malocclusion. Group A representing skeletal class I malocclusion showed a mean AN ratio of 0.55 and a standard deviation of 0.112. Whereas Group B showed a mean of 0.67 and standard deviation of 0.130. Adenoidal nasopharyngeal ratio and Angle Class of malocclusion showed a strong positive correlation

Conclusion: A clear association has been established between reduced airway volumes and skeletal class II malocclusion. AN ratio can be used as a new parameter : determined with only Lateral cephalogram, helps assess whether class II malocclusion is related to hypertrophied adenoids/ narrowing of upper airway. Early intervention and appropriate treatment can mitigate the negative impacts on airway volume, improving overall health and quality of life for individuals with Class II malocclusion.

The relationship between airway and skeletal Class II malocclusion is a topic of significant interest in the field of orthodontics and dentofacial orthopaedics. Understanding this correlation is crucial for diagnosing and treating patients with Class II malocclusions effectively.

Orthodontists have since long been piqued by the association between mode of breathing and craniofacial growth. The pharyngeal structures play an important role during breathing and swallowing functions. The pharynx can be anatomically separated into nasopharynx, oropharynx and laryngopharynx. It has been proposed that the nasopharynx and oropharynx may vary in dimensions based on orthopaedic therapy or craniofacial growth. [1]

Structural abnormalities in the upper airway can contribute to partial or complete airway obstruction. When this occurs, the resulting disruption in function can lead to a predominant mouth-breathing pattern, which may affect craniofacial development and the shape of the dental arch, potentially resulting in malocclusion.

Adenoid hypertrophy (AH) has been extensively linked to various health issues, particularly cardiopulmonary complications, disturbances in craniofacial growth, and obstructive sleep apnea (OSA). [2] The condition leads to a spectrum of nasopharyngeal obstructions, which manifest through symptoms such as mouth breathing, snoring, and disrupted craniofacial development. Patients with AH often exhibit a distinctive "adenoid face," characterized by a narrow and high maxillary arch, an abnormal tongue position, and a retruded mandible.[3] Early identification of these airflow alterations in orthodontic patients is crucial for preventing further complications and ensuring appropriate intervention.

Upper airway resistant syndrome (UARS) in children is connected with mild developmental anomalies in craniofacial skeleton and enlarged tonsils and adenoids.[4] Adenoid hypertrophy restricts nasopharyngeal patency and leads to alterations in the growth of the facial skeleton as well as muscle function, jointly referred to as ‘adenoid face’. Alterations in the structure of facial skeleton consist of enlarged lower third of the face and a steep mandibular plane. The anterior and particularly the anteroinferior part of the face become enlarged, whereas the posterior facial height is decreased. The clinical picture also includes malocclusion, commonly of skeletal nature. The maxillary dental arch becomes constricted, which results in teeth crowding and the mouth being constantly open leads to distocclusion commonly observed in these type of patients. Thus leading to development of a skeletal class II malocclusion.

Adenoidal-nasopharyngeal ratios (AN ratios) reliably expresses adenoidal size and patency of the nasopharyngeal airway. The size of the adenoids and the nasopharyngeal space are major factors that determine the nasopharyngeal obstruction. AN ratio is simple arithmetic measure that give us greater insight into the underlying cause of the developing malocclusion. They can be obtained by linear measurements from lateral cephalograms. [5]

Materials and methods:

The sample consisted of 40 individuals within the age group of 10 to 16 years, randomly selected from patients reporting to the department for orthodontic treatment.

In this cross-sectional study, a sample of 40 individuals was taken. The subjects enrolled into the present study were further divided into groups based on cephalometric measurements for skeletal base. For assessing the anteroposterior jaw relations, ANB angle was considered and divided as skeletal class I (<3deg) and class II groups (>3 deg) respectively. The inclusion criteria of the study included normal healthy subjects without clinical signs and symptoms of pharyngeal pathology and no prior history of orthodontic treatment. Patients with history of syndrome or cleft lip and palate were excluded. Individuals exhibiting class III malocclusion were also excluded.

Methods

The study was explained to all the participants and informed consent was obtained from the legal guardians. Digital Lateral cephalograms were obtained using a standardized technique.

Standardization for obtaining digital cephalogram

All the lateral cephalograms were taken with the patient standing in natural head position (NHP). At a distance of one and a half feet from the cephalostat a mirror was placed, and the subject's head was secured in cephalostat (Carestream CS 8100SC) and was asked to relax his lips and look into his own eyes. Additionally, the subject was also asked to bite on the posterior teeth adopting the position they normally keep in while chewing. The exposure parameters of the lateral cephalogram included exposure time: 10 s, voltage: 80 kV, and current: 10mA.

The subjects were instructed to be still, keep their tongue still and to refrain from swallowing during the exposure. All cephalograms were taken with identical exposure settings and using the same machine. A single calibrated examiner performed the tracings.

The Lateral cephalograms were interpreted as per guidelines provided by Fujioka et al [5]. The following linear measurements were made,

- **Adenoidal measurement (A)**: A reference line (B) is drawn along inferior margin of basiocciput. A' is marked as point representing maximal convexity along inferior margin of adenoid shadow. The distance from A' to Line B is measured by dropping a perpendicular from A' to Line B, and the distance from A' to intersection of the perpendicular with line B is measured and this gives Adenoidal measurement (A) Fig. 1
- **Nasopharyngeal space measurement (N)** : Mark two points; The anteroinferior edge of sphenobasioccipital synchondrosis (C') and the posterior-superior edge of the hard

palate (D'). The distance between C' and D' represents the nasopharyngeal space. Fig. 2

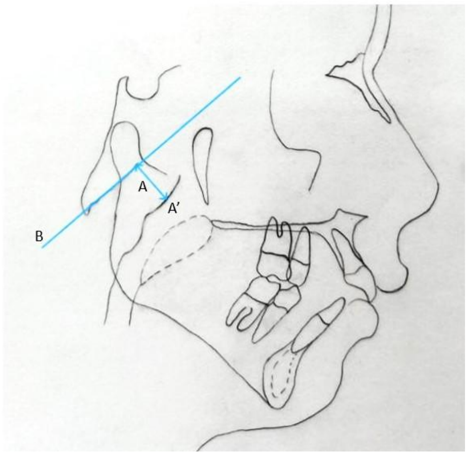


Figure 1.

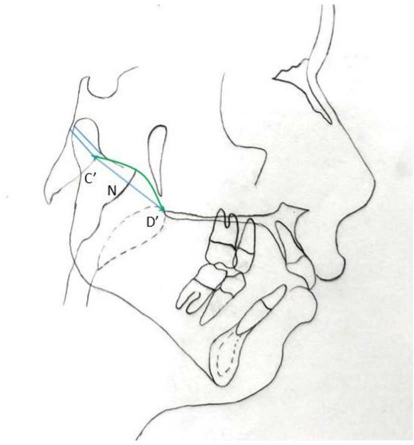


Figure 2.

The AN ratio is obtained by dividing the measurement for A by the value for N.

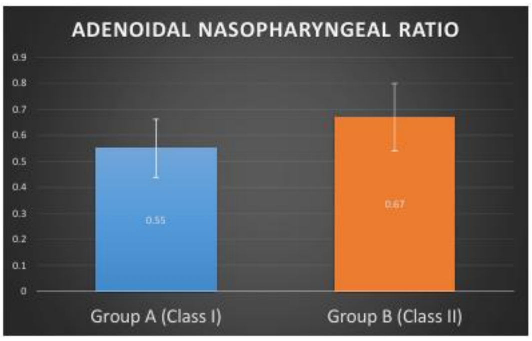
Adenoidal nasopharyngeal ratio was assessed for all the subjects. Then the AN ratio from each of these lateral cephalograms was plotted against the skeletal class of malocclusion for correlation with skeletal class I and class II subjects.

Result

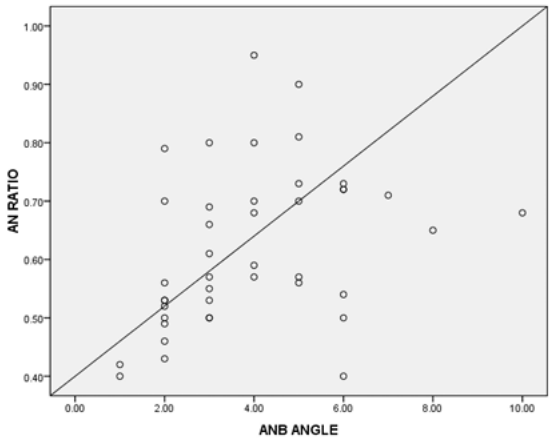
The total sample of 40 subjects was divided into two groups. The groups were divided based on ANB angle, Group A comprised of individuals with ANB <3deg i.e. Skeletal class I malocclusion and Group B comprised of individuals with ANB >3deg i.e. Skeletal class II malocclusion.

Group A comprising of skeletal class I malocclusion showed a mean AN ratio of 0.55 and a standard deviation of 0.112. Whereas Group B showed a mean of 0.67 and standard deviation of 0.130.

Table 1:



Adenoidal nasopharyngeal ratio and Angle Class of malocclusion showed a strong positive correlation. Statistically significant differences were seen for the AN ratios in the two groups of Class I and Class II malocclusion and demonstrates that the differences in mean values among the grades were statistically significant with p values of less than 0.05.



Discussion

Lateral cephalometric radiographs have been a crucial tool for evaluating soft palate and nasopharyngeal dimensions, aiding in the diagnosis of obstructive sleep apnea, cleft palate, and even in studies of individuals without these conditions. Additionally, various studies have explored the soft palate and superior pharyngeal space using advanced cutting-edge imaging technologies such as cine-computed tomography (CT), nasopharyngoscopy, videofluoroscopy, and magnetic resonance imaging (MRI)[6, 7, 8]. However, due to their high costs and significant radiation exposure, these techniques are more appropriate for patients with established soft palate dysfunctions or velopharyngeal incompetence.

Lateral cephalometric radiographs are relatively inexpensive and particularly useful for patients undergoing orthodontic treatment, as they involve reduced radiation exposure and provide clear visibility of the soft palate and surrounding structures [9]. Additionally, these radiographs can reveal various craniofacial characteristics often linked to obstructed airways[8]. Johnston and Richardson [10] discovered that small, retrognathic skeletal structures, a reduced airway, and an increased length and width of the soft palate can increase the risk of developing obstructive sleep apnea (OSA).

When airway mesurements in the two groups were compared, significant differences were appreciated, with Class I patients having nasopharyngeal dimensions relatively greater in size and thus a smaller value of adenoidal nasopharyngeal ratio (Table 1). This data corroborate the majority of studies found in the literature.[11, 12, 13, 14] Some studies namely by Freitas et al [15] as well as Memon, Fida and Shaikh [16] found that widths of the oropharynx and nasopharynx showed no correlation when Class I and Class II subjects were compared. The methods employed in our studies, may owe to the differences observed in our results, since those studies included a Class II sample considering the dental occlusion and may have included subjects with Class II resulting from maxillary prognathism, whereas in our study, a skeletal Class II malocclusion was confirmed based on ANB angles measured from cephalometric readings and in individuals exhibiting mandibular retrognathism.

From the perspective of morphological changes, the AN ratio on a lateral cephalogram may be applied as a useful screening method for estimating the nasopharyngeal airway volume [17] and potential airway obstructions. The present study reinforces the impact of the AN ratio by its association with development of class II malocclusion.

Conclusion

A clear association has been established between reduced airway volumes and skeletal class II malocclusion. This relationship underscores the importance of comprehensive diagnosis and treatment planning in orthodontics, considering both dental and airway factors. The AN ratio can be used as a new parameter : determined with only a lateral cephalogram, which helps assess whether class II malocclusion is related to hypertrophied adenoids/upper airway narrowing. Early intervention and appropriate treatment can mitigate the negative impacts on airway volume, thus improving overall health and quality of life for individuals with Class II malocclusion. Further research, particularly longitudinal studies and three-dimensional analyses of the airway, are essential to better understand the dynamics of this association and optimize treatment protocols.

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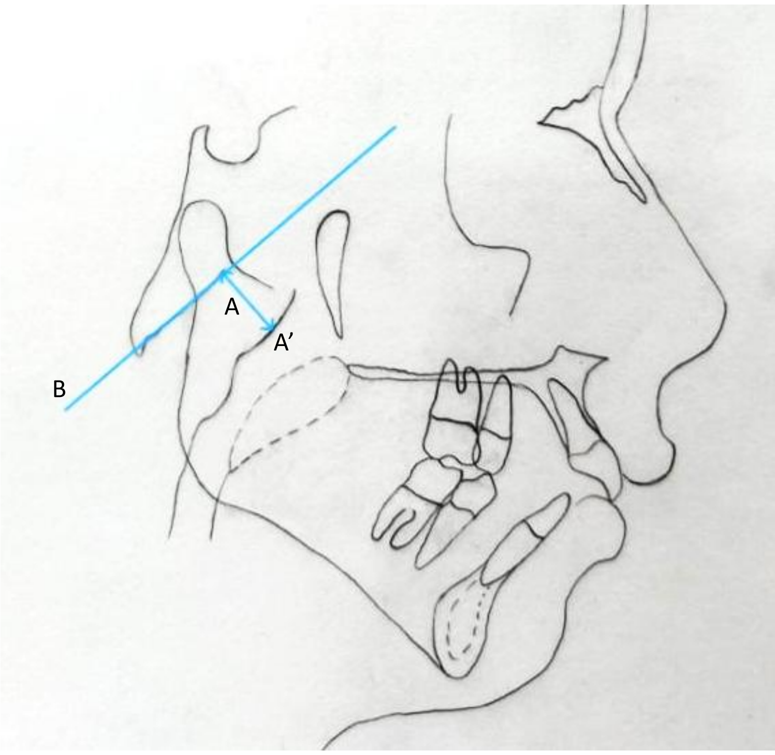
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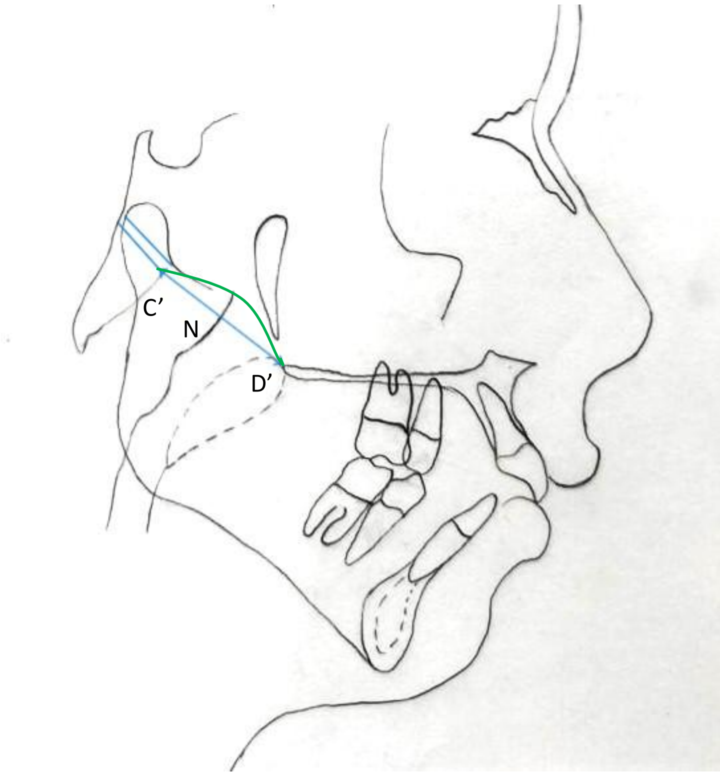
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