Research Article

Nasopharyngeal space in patients with vertical growth pattern and different anterior posterior malocclusions

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Abstract

Introduction: There has always been debate regarding the relationship between vertical growth pattern and obstruction of the upper and lower pharyngeal airways.

Objectives: The present study was conducted to compare the dimensions of airway in cephalometric radiographs of patients with skeletal class I, II and III malocclusions, which all have a vertical growth pattern.

Methods: 66 lateral cephalometric radiographs, all of which had a vertical growth pattern, were selected, and divided into three groups (class I, II and III). The points and reference lines required to measure the area of the airway were identified. The percentage of the nasopharyngeal area occupied by the airway was calculated, and data were analyzed by SPSS version 25 software. The results were presented using ANOVA analysis of variance and multiple comparisons of Tukey HSD. The significance level was 0.05 (P <0.05).

Results: The mean percentage of nasopharyngeal space occupied by the airway was 44.72% in class I, 45.58% in class II, and 49.12% in class III, but their differences were not statistically significant. Bony depth of nasopharyngeal space in class I is greater than in class II and class II greater than in class III, which had a significant difference between class I and class III (P value= 0.027). Also, the bony height of the nasopharyngeal space in class III was greater than in class I and class I greater than in class II, which was significantly different between classes II and III (P value= 0.017).

Conclusion: Anterior-posterior malocclusion does not affect the nasopharyngeal bone area, the adenoid area, and the airway area, as well as the percentage of the air area.

Introduction

One of the important components in the diagnostic process and treatment planning in orthodontics is the patient's respiratory function. One of the most important elements involved in respiration is the upper air spaces. The upper airway is consisted of nasopharyngeal, oropharyngeal and hypopharyngeal airways and has important functions in respiration and swallowing [1]. There is disagreement about the etiological role of adenoid hypertrophy in facial development and dental and skeletal abnormalities [2]. Normally, the adenoid in children is large and gradually degenerate with age. The large size of the adenoids increases the resistance to the flow of nasal air, and the child progresses to oral respiration [3].

According to research by Fujika, et al. [4]. The relationship between adenoid size and nasopharynx is of importance
and is proportional to the size of adenoids and the width of the nasopharynx at fixed points. The ratio of adenoids to nasopharynx \( \frac{A}{N} \) can be easily calculated with linear measurements of lateral cephalograms. This ratio indicates adenoids and airway openness as well as airway percentage [5]. There is a close relationship between the size of the airway space and the morphology of the face, and this space is affected by anterior functional shift, head position, anterior posterior relations, and vertical growth pattern [6]. Lateral cephalometric radiography has been used in orthodontics for many years to evaluate the growth and development of craniofacial structures, skeletal disproportions, and soft tissue [7].

With the use of cephalometry, in addition to reducing the cost and amount of radiation received by the patient, valid and repeatable information on the airway can be obtained. Various studies have shown that although measurements obtained from lateral cephalometry provide two-dimensional information, in airway assessment, it is also a reliable way to estimate adenoid size [2,8,9]. The size of the adenoid obtained from rhinoscopy is also related to what is seen on the lateral cephalogram [10].

Despite various studies on the subject, little research has been done on the possibility of a link between nasopharyngeal morphology and occlusal components and also facial growth and development. The question is whether the occlusion and growth and development of the face are affected by the narrowing of the nasopharyngeal space in people with normal breathing.

Studies have shown that the vertical growth pattern is associated with obstruction of the upper and lower pharyngeal airways as well as oral respiration [11–13]. Patients with class I and class II malocclusions and vertical growth patterns have significantly lower upper airway paths than those with class I and class II malocclusions and normal growth patterns [11].

Therefore, the present study aims to compare cephalometric airspace in Class I, II and III skeletal malocclusions, all of which have a vertical growth pattern. Because linear measurement of the soft tissue of the nasopharyngeal space is not reliable [14], measuring the area of the nasopharyngeal space can be helpful. Therefore, in this study, in addition to linear measurement of nasopharyngeal space, nasopharyngeal area and airway area as well as airway percentage were studied.

**Methods**

This study was approved by the Ethics in Research Committee under control number IR.SSU.REC.1395.159. Sampling was done by simple random sampling method and considering the significance level of 5% and test power of 80%, 22 people in each group and a total of 66 people were required. The cephalometric radiographs of 66 patients aged between 8 and 18 years who were referred to the orthodontic department of the School of Dentistry, were examined. The samples all had a vertical growth pattern. This age range was chosen because the maxillary bone growth was complete, and the size of the adenoid ranged from the largest to the smallest among the samples. Conditions for entering the study included: no oral respiration, no nocturnal snoring, no history of adenoid removal, no oral habits, no history of facial fractures, no history of orthodontic treatment and corrective orthognathic surgery, the absence of temporomandibular joint disease and the absence of various syndromes.

Radiographs with standard conditions (resting lips, teeth in occlusion, and natural head position) were selected, which also had sufficient clarity. Also, the conditions for excluding the samples from the study were: lack of clarity and quality of radiographs and incompleteness of patients’ files.

**Cephalometric analysis**

The dimensions of the pharyngeal space were measured on all radiographs (Figure 1). The vertical growth pattern of the samples was selected based on ANB angle [15]:

- **Group A:** Class I malocclusion (ANB 1°– 4°)
- **Group B:** Class II malocclusion (ANB > 4°)
- **Group C:** Class III malocclusion (ANB < 1°)

The Wits index was also used to determine the type of antero–posterior occlusion. The number of samples in each group was 22.

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One of the most challenging issues in orthodontics is the relationship between airway and face morphology. Many studies have examined this relationship, and each has used different methods to measure and analyze the nasopharyngeal space. One of the most commonly used methods for measuring the nasopharyngeal space is cephalometric analysis. Cephalometric analysis involves the measurement of various bony landmarks and planes, and the analysis of the relationships between these landmarks and planes. The variables measured in the present study are presented in Tables 1, 2, and 3.

**Results**

The variables measured in the present study are presented in Table 1. The results of the ANOVA test showed that there were no significant statistical differences between the different study groups in terms of the PMP to the point of intersection of the PL and AAL planes, PP, Ad-PMP, NP area, Adenoid area, Air area, and Air area%. The Ba-PMP and Height variables had a significant difference between the groups, so that the Ba-PMP variable in class I was greater than class II and class II greater than class III. The Height variable in class III was greater than class I and class I was greater than class II. The Tukey test was performed for these two statistically significant variables. The results of this test are given in Table 3.

According to the ANOVA test and Table 2, the differences observed in the PMP to the point of intersection of the PL and AAL planes, NP area, Ad-PMP, Adenoid area, Air area, and Air area% were not statistically significant (P > 0.05).

**Discussion**

One of the most challenging issues in orthodontics is the relationship between airway and face morphology. Many studies have examined this relationship, and each has used different methods to measure and analyze the nasopharyngeal space. One of the most commonly used methods for measuring the nasopharyngeal space is cephalometric analysis. Cephalometric analysis involves the measurement of various bony landmarks and planes, and the analysis of the relationships between these landmarks and planes. The variables measured in the present study are presented in Tables 1, 2, and 3.

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different methods to examine the dimensions of airway [16-18]. Since diagnostic records can be used before routine orthodontic treatment and thus avoid giving the patient an additional dose of radiation [19,20], lateral cephalometry radiography was used in this study. Studies have shown that the use of lateral cephalometry to measure the nasopharyngeal area is quite valid [21, 22]. Also, Aboudara, et al. [23] compared the lateral cephalometry and CBCT radiographs in the airway assessment and found that the lateral cephalometry provided a good indicator of the openness of the nasopharyngeal airway. Since the vertical growth pattern has the greatest impact on the dimensions of the airway [11,24-26], in the present study, all samples were patients with a vertical growth pattern.

Among the variables measured in the present study, the two variables of nasopharyngeal bony depth and anterior height of nasopharyngeal space were significantly different between groups, while the bony depth of nasopharyngeal space was smaller in skeletal class III group and its height was greater in skeletal class III group.

Islamian, et al. [26] showed that malocclusions in the sagittal plane could affect the depth of the nasopharyngeal space, so that in class III patients this depth is lower. Such a finding seems to be due to the greater posterior position of the maxilla in class III patients.

The other measured variables did not differ significantly between different groups. In a study, Ceylan, et al. [27] examined the nasopharyngeal area and concluded that the variable was not affected by sagittal malocclusions, stating that the oropharyngeal space was more affected by anterior-posterior malocclusion. They also showed that the anterior height of the nasopharyngeal area in class II was more than class I and in class I more than class III, but this variable was not significant in their study. In the same study, the depth of the nasopharyngeal area (Ba-PNS) was examined, which was higher in class II compared to class I and in class III compared to class I, but this difference was not significant in their study. The reason for the difference between the results of the present study and the study of Ceylan et al. can be the number of samples and that our study was only on the vertical growth pattern.

Freits, et al. [11] and Sosa, et al. [28], found similar results with our study, stating that the width of nasopharyngeal area is not affected by sagittal malocclusion. Memon, et al. [12], using McNamara’s analysis to assess airway dimensions, concluded that sagittal malocclusion did not affect the width of the upper pharyngeal region. In the present study, the airway depth of the nasopharyngeal region did not show a significant difference between the study groups.

In a study of the depth of the nasopharyngeal airway, Zhong, et al. [29] found similar results and concluded that the dimensions of the upper airway were not affected by sagittal malocclusion, but that sagittal malocclusions had a greater effect on hypopharyngeal and palatopharyngeal dimensions, so that in class III patients, these dimensions are larger.

Another variable that was not affected by sagittal malocclusion was the anterior-posterior bony depth of the nasopharyngeal area. Tourne, et al. [30] And Handleman and Osborne [31] found similar results, stating that the depth is stabilized at an early age and usually remained the same. For this reason, sagittal malocclusion may not affect the anterior-posterior bony depth of the nasopharyngeal area.

**Conclusion**

This study showed that in patients with a vertical growth pattern, there was no significant difference between nasopharyngeal area, airway area and adenoid area, as well as the percentage of airway between different anterior-posterior malocclusions and that, anterior-posterior malocclusion does not affect the nasopharyngeal bony area, the adenoid area, and the airway area, as well as the percentage of airway. However, anterior-posterior malocclusion may affect the nasopharyngeal depth (Ba-PMP) and its height.

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