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Assessment of the correlation between Pharyngeal Airways and Palatal Index in different skeletal growth patterns

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Abstract: *In the discipline of orthodontics, a person's face structure can be ascertained through the specific characteristics and anatomical correlations of the palate depth, width, and airway dimensions, which aid in the identification of malocclusions. A greater awareness of the relationship between upper airway structure and sleep disordered breathing, as well as the relationship between this condition and craniofacial morphology in general, has led to a gradual increase in interest in upper and lower airway dimensions over the past few decades. The study comprised 30 participants, with a mean age of 17.5 years. Skeletal classes I, II, and III were assigned to the participants based on their ANB (A point, nasion, B point) angle (N = 10). The study models were used to calculate the palatal height, palatal breadth, and palatal height index using Korkhaus analysis. McNamara Airway Analysis was used to measure the upper and lower pharyngeal airway dimensions based on the lateral cephalogram. The ANOVA test was used to calculate the findings. For the palatal index and airway dimensions, there was a statistically significant difference observed in all three groups of malocclusions (class I, II, and III). The subjects with skeletal class II malocclusion showed the highest mean palatal index values (P=0.03). For the upper airway, class I had the greatest mean value (P=0.041), while class III had the highest mean value (P=0.026) for the lower airway. It was concluded that subjects with the class II skeletal pattern have a high palate and reduced upper and lower airways when compared with class I and class III skeletal patterns, which showed larger upper and lower airways, respectively.*

Keywords: Orthodontics, Diagnosis, Malocclusion, Orthodontic appliances, Dental Arch.

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Introduction

In the discipline of orthodontics, a person's face structure can be ascertained through the specific characteristics and anatomical correlations of the palate depth, width, and airway dimensions, which aid in the identification of malocclusions. Since sleep-disordered breathing has been linked to upper airway shape [1] and has been linked to general craniofacial morphology, interest in upper and lower airway dimensions has gradually grown over the past few decades. The palate has been the subject of numerous research, some of which traced the palate's transverse, median, and sagittal shapes at various developmental stages in dental casts to look into changes in the palate's growth [2]. Certain conditions, such as Treacher-Collin syndrome, Apert's syndrome, Turner's syndrome, etc., might have a high or narrow palate [3]. The development of craniofacial form and occlusal patterns depends on a number of factors. The effects of upper airway obstruction on dental development and craniofacial growth require a thorough examination. Clinical trials have linked mouth breathing to the development of skeletal and dental abnormalities [4, 5]. In orthodontics, changes to the upper airway must always be evaluated clinically before starting therapy, in addition to using cone beam computed tomography (CBCT) or lateral cephalograms. Since cephalometry converts three-dimensional traits into two-dimensional ones, the information it provides is scant.

However, because CBCT creates projections on many planes and shows dimensional structures in 3D, it offers a wealth of diagnostic information that enables us to measure the volume of different structures. Breathing becomes even more difficult when there is obstruction of the upper airways, which can also result in malocclusion, jaw deformity, and craniofacial abnormalities. Furthermore, research has demonstrated that aberrant craniofacial development can result in a lifetime of health issues, including chronic mouth breathing, sleep apnea, respiratory impairment, airway obstruction, and sleep disorders [6]. In the craniofacial hierarchy, the craniofacial form and function may be ranked highest. Therefore, it is important to carefully regulate the shape and function of the craniofacial region, especially in the early phases of growth and development, using orthodontic and orthopedic therapy. First developed by Korkhaus [4], the palatal height index is derived from the combination of palatal width and palatal depth. The McNamara airway analysis is used to determine the upper and lower pharyngeal airway measures [7]. There appears to be variation in the shape of palatal vaults in each skeletal pattern, thus further research is necessary to thoroughly investigate airway and palatal morphology for improved treatment-plan formulation. There is also a connection between craniofacial development and airway development.

Thus, in class I, II, and III skeletal morphologies, our study's goal is to link palatal index index with pharyngeal airway.

Materials and methods

The Department of Orthodontics and Propaedeutics of Orthopaedic Dentistry at Bogomolets National Medical Universityin Kyiv, Ukraine, conducted the research of this study. Thirty individuals were randomly chosen from among the patients who came to the department for orthodontic treatment in order to get lateral cephalograms and dental plaster models. Using the G*Power program 3.1.9.2 (Erdfelder, Faul, & Buchner, Germany), the sample size was determined. The ANB (A point, nasion, B point) angle and wits appraisal were used to categorize the participants into three groups, Class I, II, and III, according to the type of sagittal relationship. Patients with class I skeletal bases and ANB values between 0° and 2° made up Group I. Patients in Group II included those with class II skeletal bases and ANB levels higher than 2°. Finally, group III patients had class III skeletal bases with ANB lesser than 0°. The individuals' eyes were reflected in a mirror five feet in front of them, and their teeth were in centric occlusion with the Frankfort horizontal plane parallel to the ground, as this was the normal head posture used to acquire the lateral cephalograms. To keep the head from spinning during exposure, ear rods and nasal support were used to stabilize the position. Using a 2H pencil, all cephalogram tracings were completed by hand on clear acetate

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sheets. For each patient, the McNamara airway analysis was used to record the upper and lower airway dimensions [7].

From a point on the back of the soft palate outline to the nearest point on the posterior pharyngeal wall, the upper pharyngeal breadth is measured. Because the region just next to the posterior nasal aperture is crucial for assessing upper respiratory patency, this measurement is performed on the anterior half of the soft palate outline. A two-dimensional depiction of a three-dimensional structure is the nasopharynx head film outline (Figure 1). The location on the posterior pharyngeal wall closest to the junction of the inferior border of the mandible and the posterior border of the tongue is where the lower pharyngeal width is measured (Figure 1) [8].

Alginate impression material (Hydrogum 5, Zhermack) was used to create the impressions required to make the study models, which are built of Type 3 Gypsum. Using a divider and scale, each subject's palatal index was independently determined on the study models for the Korkhaus analysis. The width measured the separation at the cervical line between the maxillary first permanent molars. The height was the shortest path between the plane defined by the other reference points and the midline where the hard and soft palates converge [4].

The palatal height Index was calculated using the following formula (Figure 2): Palatal height index = palatal height/palatal width × 100.

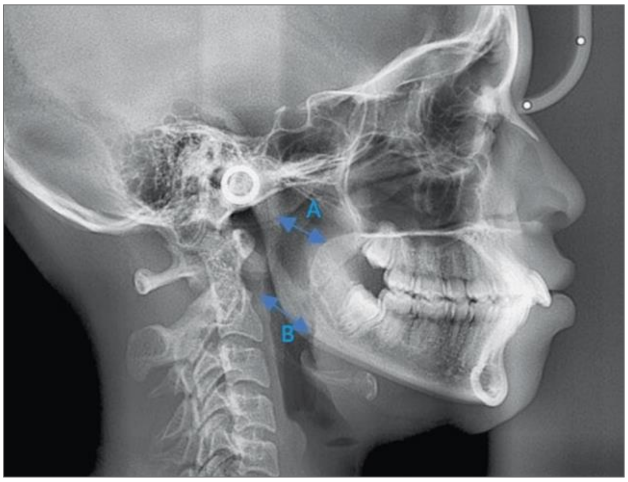

Figure 1: Measurement of the upper airway (A) and lower airway (B) on a lateral cephalogram

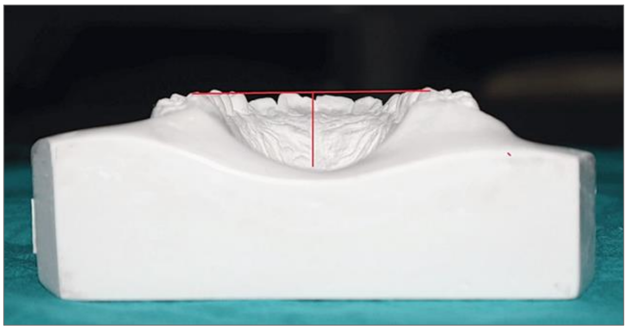

Figure 2: Study model showing palatal height and width

Statistical analysis:

IBM SPSS software for Windows, version 21 was used for data analysis. The palatal index, lower airway, and upper airway differences between the three classes were ascertained using the ANOVA test. The standard deviation and mean of the palatal index, upper airway, and lower airway in classes I, II, and III were calculated using descriptive statistics.

Results

Tables 1-3 display the descriptive data and an ANOVA test comparison of the palatal index with the upper and lower airways. The palatal index mean and standard deviations for each of the three classes are shown in Table 1, along with the findings of the ANOVA test, which indicates that there is a statistically significant difference in the palatal index between the three classes, with class II having the highest mean value (47.20). Table 2 indicates that class I had the highest mean upper airway (11.90) out of the three classes. The ANOVA test's p-value of 0.04 suggests that there is a statistically significant difference between the three groups. According to Table 3, class III had the greatest mean lower airway (12.90), and there was a statistically significant difference in lower airway across the three classes (p-value = 0.026).

Discussion

Environmental influences, eating habits, and ethnicity have all been found to affect palate dimensions. Each race or racial group has a unique cranium and facial structure. Individuals from other nations and cultures may also vary from one another in terms of their characteristics and facial features [8]. The palate morphology is a crucial sign of the anatomical structure that can

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Table 1: The Anova-test for palatal index

Class	N	Mean	Standard deviation	F-value	P-value
Class I	10	43.720	1.726		0.03*
Class II	10	47.200	5.788	1.777	
Class III	10	43.040	6.065		

Table 2: The Anova-test for upper airway

Class	N	Mean	Standard deviation	F-value	P-value
Class I	10	11.90	3.315		0.041*
Class II	10	11.80	2.486	0.174	
Class III	10	11.10	2.751		

Table 3: The Anova-test for lower airway

Class	N	Mean	Standard deviation	F-value	P-value
Class I	10	10.20	2.860		
Class II	10	10.00	2.789	2.562	0.026*
Class III	10	12.90	3.843		

alter the skeletal pattern because the craniofacial complex also comprises the face [9]. For this reason, knowledge of the morphometrics of the hard palate is clearly useful in several dental specialties, such as orthognathic surgery and orthodontics [10,11]. Our study attempted to correlate palatal depth with pharyngeal airway in class I, II, and III malocclusions because airway and craniofacial development are associated. The ANOVA test was used in this investigation to compute and compare the mean and standard deviations of the palatal index for each of the three classes. According to the results, there is a statistically significant difference in the palatal index across the three classes, with class II having the highest mean value. This implies that the palatal index was greater in individuals with class II malocclusion than in ordinary participants. This may be due to the fact that class II malocclusion has a broad range of arch-form aberrations and a varied etiology, which may include thumb sucking habits. High palatal vaults are primarily caused by thumb sucking [12]. Research by Linder A [13], Gwynne-Evans [14], and Klein [15] revealed this. They discovered that those who mouth breathe, had adenoid hypertrophy, or habitually sucked their thumbs had higher palatal heights. In those cases, a class II malocclusion was also evident. According to our study, there was a statistically significant difference between the three classes, with the mean upper airway being the highest in class I patients out of all three. According to Balter's theory [16], class II malocclusions are caused by the tongue being positioned backward. An blockage of the respiratory function in the pharynx region causes incorrect deglutition and mouth breathing. Thus, when compared to other malocclusions, the mean value of the class I malocclusion was larger. This was in line with a research that Jain et al. [17] did. Similar findings were found in another study by Flores-Blancas et al. [18]: nasopharyngeal linear anteroposterior widths are wider in brachyfacial individuals with class I malocclusion than in mesofacial and dolichofacial individuals. In this study, class III patients had the highest mean lower airway, and there was a statistically

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significant difference in lower airway between the three classes. This implies that compared to skeletal class I and II samples, all lower pharyngeal airway features showed significantly greater values in skeletal class III malocclusion samples. This may indicate a forward tongue position, which is linked to skeletal class III malocclusion. These discoveries corroborate the findings of McNamara [7], who suggested that an increase in the lower pharyngeal airway size more than 15 mm indicates a forward-placed tongue. This was as similar as a study done by Jain et al. [18] who also found the same results. These results indicate a close link between the pharynx and dentofacial structures, and suggest that the pharyngeal structures and dentofacial pattern will interact. This stimulates interest in orthodontics. Therefore, it is important to recognize the clinical significance of the pharyngeal airway, particularly in adolescents whose maxillary and mandibular growth and development are critical. This information is also necessary for the diagnosis of the developing class III malocclusion brought on by the tongue's forward orientation. The tongue's forward position may be caused by visceral interferences, such as an enlarged tongue, expanded lymphoid tissue, or respiratory embarrassment. Another scenario is that small upper and lower pharyngeal airways can aid in the early detection of class II malocclusion and the more effective use of growth modification tools to address the malocclusion. In order to detect and prevent the emergence of malocclusion at the proper time, a qualified physician may be able to use this information to test patients for probable respiratory disorders at an early stage and to initiate suitable medication at the relevant time [19]. Cephalometric films were found by Malkoc et al. to be extremely dependable and repeatable for pharyngeal airway dimension estimation [20]. Since the study was carried out on a general population, these conclusions can be extended to different populations. Even said, one potential drawback of the current study could be its smaller sample size. In order to link the pharyngeal airway with the palate depth in all skeletal configurations with greater sample sizes, more research is necessary.

Conclusion

When comparing class II malocclusion participants to class I and class III subjects, the palatal index of the latter group showed the greatest mean value. Class I malocclusions had the highest mean value for the upper airway when compared to class II and class III malocclusions. Furthermore, class III malocclusions had the highest mean value for the lower airway when compared to class I and class II malocclusions.

Financing

The research received no external funding.

Conflict of interest

The authors declare no conflict of interest.

Consent of Publication

The author gives her permission for publication

AI Disclosure

The authors used ChatGPT (OpenAI, San Francisco, CA, USA) for language editing of the English text. The authors reviewed and verified all AI-generated content to ensure accuracy and integrity.

Ethical approval

"All human studies were approved by the institutional ethics committee and conducted in accordance with the Declaration of Helsinki (2013).»

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Оцінка кореляції між глотковими дихальними шляхами та піднебінним індексом при різних моделях росту скелета

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Анотація: *В ортодонтії структуру обличчя людини можна визначити за специфічними характеристиками та анатомічними кореляціями глибини, ширини та розмірів піднебіння, що допомагає у виявленні аномалій прикусу. Більш глибоке усвідомлення зв'язку між структурою верхніх дихальних шляхів та порушеннями дихання під час сну, а також зв'язку між цим станом та краніофаціальною морфологією загалом призвело до поступового зростання інтересу до розмірів верхніх та нижніх дихальних шляхів протягом останніх кількох десятиліть. У дослідженні взяли участь 30 учасників, середній вік яких становив 17,5 років. Учасникам були призначені скелетні класи I, II та III на основі їхнього кута ANB (точка A, назіон, точка B) (N = 10). Моделі дослідження використовувалися для розрахунку висоти піднебіння, ширини піднебіння та індексу висоти піднебіння за допомогою аналізу Коркхауса. Для вимірювання розмірів верхніх та нижніх глоткових дихальних шляхів на основі латеральної цефалограми використовувався аналіз дихальних шляхів Макнамари. Для розрахунку результатів використовувався тест ANOVA. Щодо піднебінного індексу та розмірів дихальних шляхів, спостерігалася статистично значуща різниця у всіх трьох групах аномалій прикусу (клас I, II та III). У суб'єктів зі скелетним аномалією II класу спостерігалися найвищі середні значення піднебінного індексу (P=0,03). Для верхніх дихальних шляхів клас I мав найбільше середнє значення (P=0,041), тоді як клас III мав найвище середнє значення (P=0,026) для нижніх дихальних шляхів. Було зроблено висновок, що суб'єкти зі скелетним типом II класу мають високе піднебіння та зменшені верхні та нижні дихальні шляхи порівняно зі скелетними типами класу I та класу III, які показали більші верхні та нижні дихальні шляхи відповідно.*

Ключові слова: ортодонтія, діагноз, патологія прикусу, ортодонтичні апарати, зубна дуга.