Malocclusion and upper airway obstruction

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Summary. *After more than a century of conjecture and heated argument, the orthodontic relevance of nasal obstruction and its assumed effect on facial growth continues to be debated. Oral respiration disrupts those muscle forces exerted by tongue, cheeks and lips upon the maxillary arch. The main characteristics of the respiratory obstruction syndrome are presence of hypertrofied tonsils or adenoids, mouth breathing, open- bite, cross-bite, excessive anterior face height, incompetent lip posture, excessive appearance of maxillary anterior teeth, narrow external nares, "V" shaped maxillary arch. The purpose of this study is to evaluate relationship between nasal obstruction and severity of malocclusion.*

The sample analyzed in this article consisted of 49 children aged from 7 to 15 years, who pronounced difficulty in breathing through the nose. Patients and their parents were interviewed, clinical examination was performed, and measurements from dental casts and panoramic radiograph were obtained. All patients were examined by otorhinolaryngologist, and the nasal obstruction was confirmed by posterior rhinomanometry test.

This study showed the significant association between nasal resistance and increased overjet (p=0.042), open bite (p=0.033) and maxillary crowding (p=0.037). The tendency of greater nasal resistance was observed for the patients with the first permanent molars relationship Angle II and posterior cross-bite.

Introduction

After more than a century of conjecture and heated argument, the orthodontic relevance of nasal obstruction and its assumed effect on facial growth continues to be debated. In 1872, Tomes indicated that children with mouth breathing often develop V-shape maxillary arch. In 1907 Angle stated that Angle's II class I division malocclusion is always followed and aggravated, or even conditioned, by mouth breathing, caused by obstruction of the upper airways (1). The causes of nasal obstruction, conditioning mouth breathing, may be hypertrophied adenoids and tonsils, chronic and allergic rhinitis, nasal traumas, congenital nasal deformities, foreign bodies, polyps, and tumors (2). One of the most common causes of mouth breathing in children is hypertrophy of pharyngeal tonsils (adenoids). The lymphatic tissue in children is small, its hypertrophy starts early, and reaches its maximum at the age of 7-8 years. This period is followed by involution, and at the age of around 20, the pharyngeal tonsil disappears completely (3).

Ricketts (1968) differentiates that the main characteristics of the respiration obstruction syndrome are presence of hypertrofied tonsils or adenoids, mouth breathing, open-bite, cross-bite and narrow external nares (4). Other features include excessive anterior face height, incompetent lip posture, right angle of the mandibular plane, and V-shaped maxillary arch (2). Linder-Aronson (1993) presented a hypothesis, stating that increased adenoids aggravate nose breathing, which disrupts the balance of lingual, labial, and cheek muscles. This results in the changes that are reflected in malocclusion and anomalies of dental position. The above-mentioned scientist thus concluded that adenoids influence the appearance of skeletal and dentoalveolar deformities (5). Harvold et al. (1981) experimentally induced nasal obstruction in animals, which resulted in mouth breathing and entailed maxillary narrowing, lowered mandibular position, increased anterior face height, malocclusion and dental anomalies (6). Further studies showed that mouth breathing also influences the increase of the lower third of the face, mandibular rotation, and the excessive mandibular angle. Nasal obstruction causes changes in muscular function, conditioning dentofacial anomalies (7,8).

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Some scientists failed to prove the existence of the relation between mouth breathing and the frequency of malocclusion. Leech (1958) determined that mouth breathing does not have any influence on dentofacial morphology (9). Gwynne-Evensend and Ballard (1959) noticed that mouth breathing induces neither changes in jaw growth, nor malocclusion and anomalies of dental position, nor influences the formation of the “adenoid” face (10).

Total nasal obstruction is a very rare phenomenon (11), whence the objective and quantitative evaluation of how much the subject breathes through mouth, and how much – through nose, is disputable. The ability to breathe through the nose is usually determined by a LOR specialist after anterior and posterior rhinoscopy (12). Clinical assessment of nasal and nasopharyngeal condition can also be performed. Simple clinical tests, observation of mirror dewing at external nares and observation whether cotton wool fibers are moved by airflow allow only for the verification of whether the subject breathes through nose or through mouth. The most reliable method for the quantitative evaluation of nasal obstruction is rhinomanometry, which is a non-invasive, fast, precise, and fixed study. It evaluates nasal resistance and airflow pressure.

The aim of the study: to evaluate the influence of mouth breathing on the frequency of malocclusion, and the formation of crowding in dental arches, first permanent molars relationship, cross-bite, and the size of overjet and overbite; to determine the interdependence between the severity of malocclusion and the degree of the obstruction of the upper airways.

The contingent of subjects and the methods of the study

Of all children who visited Orthodontic clinic of Kaunas University of Medicine in 2001, 49 subjects with nasal obstruction were selected for more profound studies. The study included patients aged 7-15 years, mean age – 10.5 years. Table 1 presents the subjects’ distribution by age and gender.

None of the subjects had undergone orthodontic treatment prior to the study.

The methods applied in the study were interview, intra-oral and extra-oral examination, analysis of diagnostic models, and orthopantomographic evaluation. All patients were examined by otorhinolaryngologist, and the nasal obstruction was confirmed by posterior rhinomanometry test, that was performed at Otorhinolaryngology clinic of Kaunas University of Medicine.

***Table 1.* Distribution of subjects by age and gender**

Age	Boys	Girls	Total
7–9 years	8/44.4%.	10/55.6%	18
10–11years	7/46.7%	8/53.3%	15
12–13 years	5/41.7%	7/58.3%	12
14–15 years	1/25%	3/75%	4
Total	21/33.3%	28/66.7%	49

During the clinical examination and model analysis the following data were evaluated:

Anomalies of the position of separate teeth: labial and palatal position and axial bend.

Overjet (OJ) – the distance between the incisor ledge of the central upper incisor and the labial surface of the central lower incisor. It was measured in millimeters and differentiated according to IOTN index (the index of the need for orthodontic treatment): 0-3.5 mm, 3.5-6 mm, 6-9 mm, and more than 9 mm (13).

Overbite (OB) – the distance between how much the crowns of the central upper incisors overlap the crowns of the central lower incisors. According to Proffit’s methods, it was differentiated into OB e” 0 mm and OB < 0 mm (14).

Cross-bite was evaluated in the sites of premolars and molars (present or absent).

Maxillary and mandibular crowding (present: the lack of space > 2 mm; absent: the lack of space < 2 mm) according to Melsen’s methods (15).

The relation between the first upper and lower molars is evaluated according to Angle’s classification: class I – the anterior vestibular cusp of the first upper molar enters the fissure of the first lower molar; class II - the anterior vestibular cusp of the first upper molar is moved distally from the fissure of the first lower molar; class III - the anterior vestibular cusp of the first upper molar is moved medially from the fissure of the first lower molar (14).

Mode of respiration: normal – through the nose, disturbed – through the mouth. A child is considered to breathe through the mouth if his/her mouth is open at rest, tension of perioral muscles is visible when the mouth is closed, and the child complains of nasal obstruction and more often breathes through the mouth (15).

During the examination by the otorhinolaryngologist, anterior and posterior rhinoscopy and pharyngoscopy were performed. Anterior rhinoscopy evaluates the condition of nasal mucosa (intumescence, discharge), possible tumors in the nasal passages, deviation of the nasal septum, and the condition of nasal conchae (intumescence, hypertrophy). Posterior rhinoscopy evaluates nasopharyngeal mucosa, and the condition of the posterior endings of nasal conchae and nasal openings of the pharynx, also nasal discharge, as well as formations located in the nasopharyngeal arch: adenoids and the degree of their hypertrophy, and other formations. Adenoids, according to their size, are differentiated into: 1st degree – the lower edge of the enlarged tonsil covers only the vault of conchae; 2nd degree – the lower edge of the enlarged tonsil reaches internal conchae; 3rd degree – the lower edge of the enlarged reaches the posterior endings of lower conchae. Pharyngoscopy evaluates the condition of the soft palate (e.g. paresis), dysplasias, and the condition of tonsils and the degree of their hypertrophy.

Rhinomanometry, or the measurement of nasal resistance (NR), is based on the measurement of nasal airflow and the pressure that induces this airflow. Posterior rhinomanometry allows for the measurement of general nasal resistance. Under ideal conditions, the pressure that rises in the mouth will equal to the pressure in the posterior nasal cavity; nasal resistance is this pressure divided by the measured airflow.

$$NR = P : F$$

NR – nasal resistance (Pa/ml/s)

P – transnasal pressure (Pa)

F – nasal airflow (ml/s)

All rhinomanometric data are calculated using SI system units: pressure – Pa, airflow – ml/s, nasal resistance – Pa/ml/s. The posterior rhinomanometry was performed using “Rhinomanometer No. 6-2” produced by “Gm instruments”, according to Brooms method with 200 units diameter circle. Nasal resistance was calculated at a point where the breathing curve crosses the line of the circle (16). Nasal resistance during inspiration and expiration was measured during each test, and the mean was calculated from the data of the four measurements.

The data obtained during the studies were registered in special questionnaires. The statistical analysis of the data was performed using “Statistica 5.0” software package, and the frequency difference in the tables of related indications was evaluated using ÷2 criterion (17).

Results and discussion

During the study, mixed dentition was found in 26 children, and permanent dentition – in 23 children. Eleven boys (42.3%) and 15 girls (57.7%) were studied during the period of mixed dentition; and 11 boys (47.8%) and 12 girls (52.2%) were studied during the period of permanent dentition. The studied children had not undergone orthodontic treatment, nor had they had any dental, facial, maxillary or mandibular traumas or surgical operations. Orthopantomography revealed overdentition of supernumerary teeth in none of the patients.

The differentiation of the subjects according to upper airway obstruction showed that 16.3% of them were healthy (3 boys and 5 girls). 1st degree adenoids were diagnosed in 28.6% of patients (5 boys and 9 girls). 2nd degree adenoids were found in 22.4% of subjects (6 boys and 5 girls). 3rd degree adenoids were detected in 4.1% of children (2 girls). The deviation of the nasal septum was found in 16.3% of patients (3 boys and 5 girls). Chronic rhinitis was diagnosed in 12.2% of subjects (3 boys and 3 girls). The diagnosis of the obstruction of the upper airways in different age groups had the following pattern: 1st degree adenoids were mostly diagnosed in children aged 10-12 years – 71.4% (10 patients); 2nd degree adenoids were most common in children aged 7-9 years – 63.6% (7 patients); 3rd degree adenoids were diagnosed only in two patients, and they were equally distributed in all age groups. The deviation of nasal septum was common in all age groups; chronic cold was most common in children aged 7-9 years – 50.2%, while only 16.7% of children aged 13-15 years had this disorder.

The mean of nasal resistance on inhalation in the studied patients was 0,34±0.24 Pa/ml/s, and on exhalation – 0.37±0.24 Pa/ml/s. When evaluating the relation between the mean of nasal resistance on inspiration and expiration and obstruction of upper airways, statistically significant differences were found between healthy children and children with 1st or 2nd degree adenoids and chronic rhinitis ($p<0.05$). The distribution of means of nasal resistance on inspiration and expiration according to upper airway obstruction is presented in Table 2.

In this study the relation between malocclusion and nasal resistance was also evaluated. The following indications of orthodontic anomalies were studied: anomalies of separate teeth, maxillary and mandibular crowding, relationship between the first permanent upper and lower molars, posterior cross-bite, and overjet and overbite.

Various anomalies in dental position were detected: in the maxillary arch, most common were anomalies of the position of incisors (65.2%), while in the mandibular arch such anomalies were found in 34.7% of subjects. According to the findings of the performed study, max-

***Table 2.* The distribution of means of nasal resistance on inspiration and expiration according to airway obstruction**

Upper airway obstruction	Nasal resistance on inspiration (Pa/ml/s)	Standard deviation	Nasal resistance on expiration (Pa/ml/s)	Standard deviation
Healthy N=8	0.12	0.05	0.14	0.07
I st degree adenoids N=14	0.40*	0.21	0.42*	0.21
II st degree adenoids N=11	0.53*	0.33	0.57*	0.29
III st degree adenoids N=2	0.47	0.22	0.53	0.23
Deviation of nasal septum N=8	0.19	0.07	0.21	0.07
Chronic rhinitis N=6	0.31*	0.11	0.35*	0.13

*p<0.05 compared to the group of healthy children

illary crowding of > 2 mm is more common (38.8%) than mandibular crowding (20.4%). It was most common in the group of patients with 3rd degree adenoids or other kinds of upper airway obstruction – 62.5%. In subjects with 1st or 2nd degree adenoids, crowding was diagnosed in 32.1% of children, and in the group of healthy children – in 12.5% of patients. The mean of nasal resistance, the quantity that quantitatively defines the condition of airways, is higher (0.37 Pa/ml/s) in subjects with crowding, than in subjects without maxillary crowding (0.29 Pa/ml/s). The association of crowding with the degree of airway obstruction is statistically significant, probability p=0.037.

When evaluating the relationship between the first permanent upper and lower molars according to Angle's classification, class I was found in 44.9% of subjects (22 children), and class II – in 55.1% of subjects (27 children). Figure 2 presents the differentiation of the relationship between the first permanent molars according to upper airway obstruction. The means of nasal resistance in case of Angle's class I relationship between the first permanent molars (0.25 Pa/ml/s) and in case of Angle's class II relationship (0.45 Pa/ml/s) did not differ significantly.

Posterior cross-bite was found in 12 patients (24,5%). The differentiation of the subjects according to upper airway obstruction showed that there were no cases of cross-bite in healthy patients. In cases of the 1st degree adenoids, cross-bite was detected in 14.3% of subjects, in case of the 2nd degree adenoids – in 45.5% of subjects, and in cases of the 3rd degree adenoids – in 50% of patients; cross-bite was also detected in 37.5% of children with deviated nasal septum and in 16.7% of patients with chronic rhinitis. The mean of nasal resistance in patients with cross-bite was 0.46 Pa/ml/s, and in children without this anomaly the mean of nasal resistance was lower – 0.31 Pa/ml/s; however, these means did not differ significantly.

Overjet of 0-3.5 mm was detected in 87.5% of healthy children, in 36.1% of children with 1st or 2nd degree adenoids, and in 37.5% of subjects with other nasal or nasopharyngeal pathologies. Overjet of 3.5-6 mm was found in 28.1% of children with 1st or 2nd degree adenoids and in 18.7% of subjects with deviated nasal septum or chronic rhinitis. Overjet of over 6 mm was detected in 12.5% of healthy children, in 36.1% of patients with 1st or 2nd degree adenoids, and in 43.7% of subjects with other nasal or nasopharyngeal anomalies. In case of overjet of 0-3.5 mm, the mean nasal resistance was 0.26 Pa/ml/s, and in case of overjet of over 3.5 mm, the mean nasal resistance was 0.41 Pa/ml/s. The association of the size of overjet with nasal resistance was statistically significant, the probability p = 0.042.

The relation of the size of overjet with nasal resistance is defined through the regression equation between nasal resistance (NR [Pa/ml/s]) and overjet (OJ [mm]). This is graphically presented in Fig. 2.

$NR = 21.64 + 2.86*OJ;$

$NR = 0.32;$

$NR2 = 0.1$

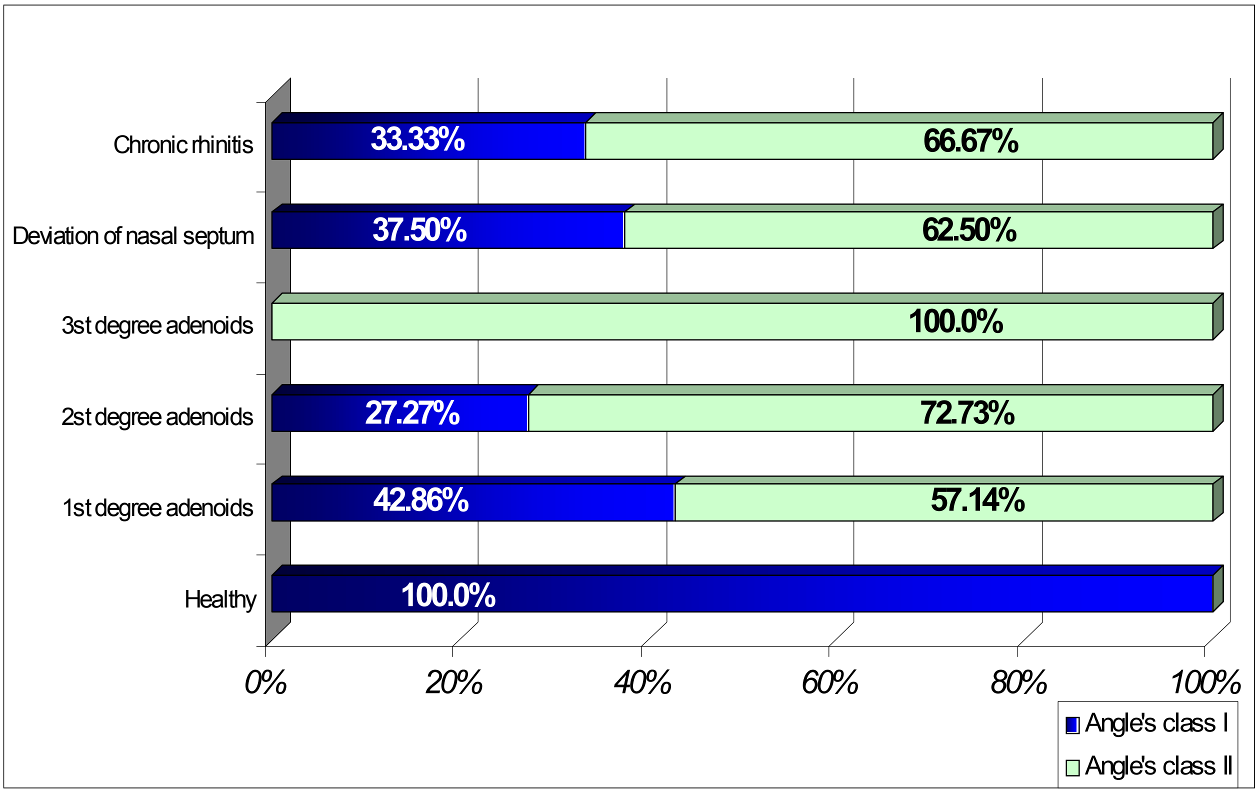

Fig. 1. **The differentiation of the relationship between the first upper and lower molars according to nasal and nasopharyngeal pathology (airway obstruction), using Angle's classification**

Nasal resistance

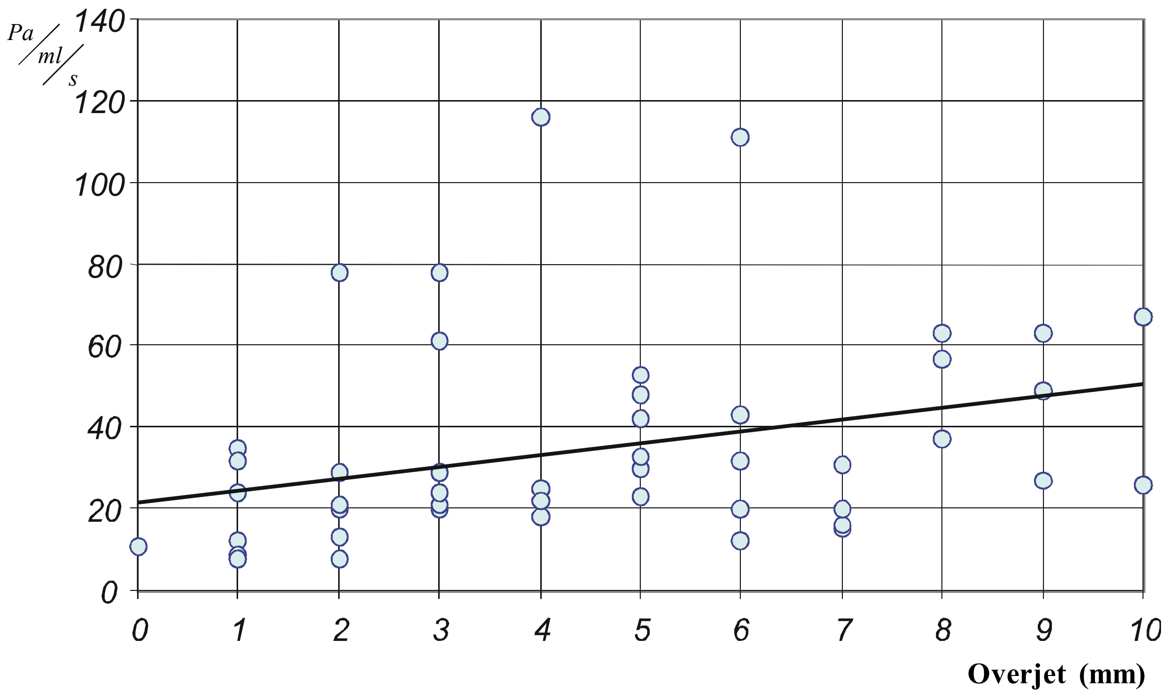

Fig. 2. **The relation between overjet and nasal resistance**

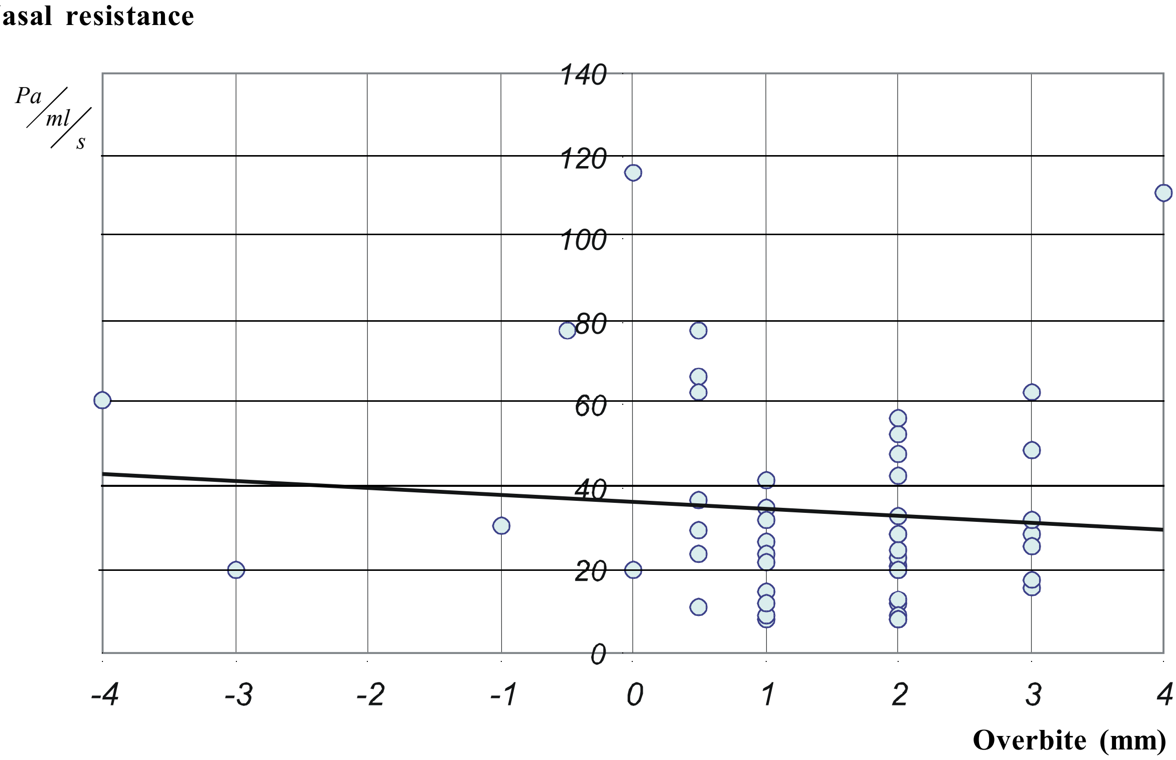

Fig. 3. **The relation between open bite and nasal resistance**

During the study, overbite of < 0 mm was diagnosed in 8.2% of patients. The relation between overbite and nasal resistance is presented in Fig. 4. The mean nasal resistance in cases of open-bite was 0.54 Pa/ml/s; and when overbite was equal to or higher than 0, mean nasal resistance was 0.31 Pa/ml/s. The association of open bite with the mean nasal resistance was statistically significant (probability p = 0.033).

The findings obtained during the study allow for stating that, with the increase in nasal resistance, increases the incidence of the indications of the following orthodontic anomalies: the anomaly of the position of the upper teeth, crowding of more than 2 mm, Angle's class II relationship between the first permanent upper and lower molars, premolar and molar cross-bite, increased overjet and overbite of < 0 mm.

Conclusions:

28.6% of patients with orthodontic anomalies had 1st degree adenoids, 22.4% - 2nd degree adenoids, and 4.1% - 3rd degree adenoids; 16.3% of these patients had deviated nasal septum, and 12.2% of them had chronic rhinitis.

The relation of orthodontic anomalies with nasal resistance was detected, as well as statistically significant association with the size of overjet (p = 0.042), the size of overbite (p = 0.033), and the frequency of maxillary crowding (p = 0.037).

A tendency was noticed that mean nasal resistance is higher in patients with Angle's class II relationship between the first permanent upper and lower molars or patients with cross-bite, compared to those with Angle's class I relationship between the first upper and lower molars or without cross-bite. However, this difference is not statistically significant.

Ortodontinės anomalijos, nosies bei nosiaryklės patologija

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Raktažodžiai: ortodontinės anomalijos, kvėpavimas pro burną, pro nosį pratekančios oro srovės pasipriešinimas.

Santrauka. Daugiau kaip šimtmetį vyksta diskusija, koks yra kvėpavimo pobūdžio poveikis ortodontinėms anomalijoms atsirasti. Kvėpuojant pro burną, pakinta normali oro srovė, slėgis nosies ir burnos ertmėse, o tai įtakoja šių struktūrų raidą. Skiriami šie viršutinių kvėpavimo takų obstrukcijos sindromo požymiai: hipertrofavusios tonzilės arba adenoidai, kvėpavimas pro burną, atviras sąkandis, kryžminis sąkandis, per didelis veido aukštis, lūpinė viršutinių kandžių padėtis, siauros nosies landos, “V” formos viršutinis dantų lankas. Tyrimo tikslas – įvertinti priklausomybę tarp ortodontinės anomalijos sunkumo ir viršutinių kvėpavimo takų obstrukcijos laipsnio. Ištirti 7–15 metų 49 vaikai, kuriems nustatyta ortodontinių anomalijų, jie skundėsi apsunkintu kvėpavimu pro nosį. Atlikta apklausa, apžiūra, diagnostinių modelių analizė, įvertintos ortopantomogramos, tiriamieji konsultuoti ausų, nosies, gerklės gydytojo, atlikta užpakalinė rinomanometrija. Tyrimo metu nustatyta statistiškai reikšminga priklausomybė tarp pro nosį pratekančios oro srovės pasipriešinimo ir šių ortodontinių anomalijų požymių: horizontalaus kandžių persidengimo (p=0,042), vertikalaus kandžių persidengimo (p=0,033) bei dantų susigrūdimo viršutiniajame dantų lanke (p=0,037). Pastebėta tendencija, kad, esant viršutinių ir apatinių pirmųjų nuolatinių krūminių dantų santykiui pagal Angle II klasę arba pacientams, turintiems kryžminį sąkandį pro nosį pratekančios oro srovės vidurkis yra didesnis negu esant Angle I klasei, arba nesant kryžminio sąkandžio, šis skirtumas statistiškai nereikšmingas.

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