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Impact of adenoid hypertrophy on the open bite in children

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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ABSTRACT: Nasal obstruction caused by adenoid hypertrophy can lead to malocclusion. The research material consisted of children aged 7–12 years with adenoid hypertrophy qualified for adenoidectomy. On the basis of the conducted tests (laryngological, orthodontic, pediatric), the occurrence of open frontal bite in children with pharyngeal tonsil hypertrophy, in particular in boys, was confirmed in comparison to children without hypertrophy correctly breathing through the nose.

KEYWORDS: adenoid hypertrophy, children, open bite

INTRODUCTION

Long-term oral breathing in the course of adenoid hypertrophy at the developmental age may lead to disturbed development of the masticatory organ, malocclusion, and dental anomalies as well as to the failure of orthodontic treatments requiring the mouth fissure being closed and the patient breathing through their nose. Environmental causes of malocclusion, including open bite, may include thumb sucking, tongue dysfunction, excessive vertical growth of facial front, chronic upper respiratory obstruction, or muscular dystrophy [19, 3]. Children with chronic nasal obstruction and adenoid hypertrophy present with a number of symptoms referred in the literature as adenoid facies or long face syndrome. Children with adenoid hypertrophy often present with open mouth fissure and short upper lip revealing upper incisors resting on the lower lip [1, 2, 12, 20]. Children with adenoid facies are pale, apathetic, experience difficulties with concentration and become easily fatigued. In children with chronic oral breathing, some predominant facial features can be observed including extension of anteroinferior facial height, small nose, mentolabial groove deepening, mental distraction, frequent protrusion of upper incisors, and lip incompetence, i.e. inability to freely close one's lips without visible strain and effort of submental muscles while swallowing and breathing through one's nose. Children with upper respiratory tract obstruction present with excessive anterior facial height which might be due to the mandible being rotated downwards and backwards, as well as to excessive vertical growth of the inferior facial segment. Also present are excessive eruption of lateral teeth, narrowing of upper dental arch, protrusion of upper incisors resting on the lower lip, partial anterior open bite, and lip incompetence. Normal overbite observed in children with habitual oral breathing is observed as being due to compensatory eruption of incisors and the resulting anterior bite closure [4, 16]. According to the WHO, malocclusion is defined as a condition of the masticatory organ causing visible disfiguration and significant restriction of patient's ability to chew and breathe, perceived by the patient to be a functional, aesthetic, and emotional problem [9]. Malocclusion is a relative indication for surgical management of adenoid hypertrophy. Temporary, acute inflammations within the upper airways have no impact on the masticatory organ. Fixation of oral breathing route in the course of adenoid hypertrophy in children may be a cause of partial anterior open bite. It is characterized by the absence of proper occlusal contact between the upper and lower anterior teeth within the horizontal plane [5].

Open bite may be either full (skeletal) including mandibular distraction or protraction (Fig. 4.), partial lateral, unilateral, including right- and or left-sided, bilateral (Fig. 2. i 3.), or partial anterior, frequently presenting with protrusion of upper incisor teeth (Fig. 1.).

Similar to most malocclusions, open bite is reflected in variable facial features. Partial anterior open bite presents with an underocclusion fissure within the anterior segment. This results in impaired chewing and speech. Interdental articulation may be present without significant changes in facial features. Complete open bite, being a gnathic (genetic) defect, is characterized by marked deflection of jaw bodies resulting in a significant underocclusion fissure. This results in difficulties with chewing and biting off pieces of food since the contact between the upper and lower teeth occurs only at the molars [1]. Facial features include elongation of the facial section, excessive exposure of upper incisors at lip rest (gummy smile), incompetence of lips at rest, excessive tension of the mental muscle upon the attempts to join one's lips as well as a small nose with narrow nostrils [16].

Nasal breathing is a physiological function such as swallowing, mastication, and speech. Disturbance of nasal breathing may negatively affect the growth of bone structures and soft tissues within the facial skeleton and consequently lead to malocclusion. Literature contains isolated, sometimes contradictory reports regarding the impact of

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Fig. 1. Partial anterior open bite.

Fig. 2. Partial lateral open bite, left-sided.

Fig. 3. Partial lateral open bite, right-sided.

Fig. 4. Full open bite with mandibular protraction.

adenoid hypertrophy on the development of malocclusion [16, 17]. Therefore, a decision was made to assess the incidence of open bite in our own study material consisting of a population of patients with nasal obstruction in the course of adenoid hypertrophy.

OBJECTIVES

1. To evaluate the incidence of open bite in children with chronic oral breathing in the course of adenoid hypertrophy.

2. To determine the potential impact of gender in the incidence of partial anterior open bite in children with chronic oral breathing in the course of adenoid hypertrophy.

MATERIAL

The study was conducted at the Department of Otolaryngology and the Department of Pediatrics of the J. Bogdanowicz Children's Hospital in Warsaw and at the Elementary School no. 354 in Warsaw (fourth-grade pupils, routine orthodontic examination as part of general dental health checkup). The study was approved by the Bioethics Committee of the Military Institute of Medicine in Warsaw, decision no. 49/WIM/2012. The study material consisted of a group of n = 236 pediatric patients aged 7–12 years.

Groups of children to be included in further studies were selected on the basis of interview data (oral breathing during the day and the night, sleep apnea) and physical examination (adenoid hypertrophy of more than 75% in endoscopic examination).

Group A consisted of 93 children aged 7–12 years: 57 boys (61.29%) and 36 girls (38.71%) with adenoid hypertrophy, qualified for surgical treatment and presenting with nasal breathing disturbances (snoring, sleep apnea).

The control group K consisted of 143 randomly selected children aged 7–12 years. As many as 71 boys (49.65%) and 72 girls (50.35%) reporting for hospital treatment without nasal breathing disturbances and elementary school fourth-graders with proper nasal breathing undergoing routine orthodontic evaluation as part of dental health checkup.

Consent for the study was obtained from parents of all children included in the study. Parents filled in a questionnaire on the incidence of daytime and nocturnal breathing disorders, clinical symptoms of allergies and oral parafunctions (thumb sucking, nail biting).

Exclusion criteria consisted of inappropriate age (below 7 or over 12 years), history of laryngological surgeries, facial skeleton anatomy defects, allergic rhinitis, chronic disorders, and lack of patient cooperation.

METHODS

Interview

The interview focused on the incidence of habitual oral breathing, snoring, sleep apnea, allergies, history of ongoing orthodontic treatment.

Physical examination

Pediatric examination was performed to exclude chronic or inflammatory disorders.

All children were subjected to ENT examination which focused particularly on the condition of nasal cavities and nasopharynx and involved endoscopic assessment of the upper pharynx (nasofiberoscopy). The size of the adenoid and the respiratory volume within the nasopharynx were scored using a 0–3 scale, where:

- 0 – no adenoid tissue;
- 1 – small adenoid taking up less than ½ of posterior nares;
- 2 – adenoid taking up ½ of posterior nares;
- 3 – adenoid taking up more than ⅔ of posterior nares.

General dental examination assessed the patient's facial features (position within the biometric area i.e. the jaw profile area), facial symmetry including any physiological asymmetries, lips (competence i.e. the ability to freely, effortlessly closing one's lips as opposed to hyper- or hypotonus), frenula of lips and tongue, tongue (size, mobility, position at rest), palate (palatine curvature), general dental condition, caries and tooth losses.

Orthodontic examination assessed the occlusal parameters within the three planes (sagittal, horizontal, and frontal plane) and the adequacy of dentition to patient's age. Angle's classification [5] was used to evaluate the relative relationship between the maxilla and the mandible in the anteroposterior dimension, where Angle class I was defined as harmonious relative position of jaws, (neutral occlusion), Angle class II was defined as posterior displacement of lower molars relative to upper molars, and Angle class III was defined as anterior displacement of lower molars relative to upper molars.

Canine classes I, II, III were used to assess patient's occlusion. Just like the Angle's classification, canine classes were used to evaluate the occlusion within the anteroposterior dimension. Overbite defined as the depth of upper incisors overlapping with their lower counterparts was assessed. Overbite was defined as the projection of the edge of the upper medial incisor on the labial surface of the lower medial incisor. Coverage of about ⅓–½ of the lower incisor's height was defined as the reference level. Overbite was measured as reference/positive/negative. Positive overbite is characteristic of deep bites while negative overbite is characteristic of open bites.

STATISTICAL ANALYSES

The nature of variables' distributions was assessed using the Shapiro-Wilk's test. The χ^2 test was used to compare the numbers of patients with individual types of malocclusion within the study groups (A and K) as well as in patients of different genders. Generalized linear model with binomial distribution and logit link function was used to determine the probability of malocclusion depending on the age and gender of patients. Results with probabilities of ≤0.05 were considered statistically significant. Statistical analyses were carried out using the Statistica 12.0 software package (Statsoft Inc. 2018).

Tab. I. Statistical analysis of the incidence of open bite in the study groups.

	GROUP A	GROUP K	TOTAL
Children without open bite	82	137	219
Percentage	34,746%	58,051%	92,797%
Children with open bite	11	6	17
Percentage	4,661%	2,542%	7,203%
Children in group	93	143	236
Percentage	39,407%	60,593%	
x^2 (df=1)	4,91	p = ,0267	
V2(df=1)	4,89	p = ,0270	
x^2, Yates correction	3,84	p = ,0502	
ϕ^2	,02081		
+ Fisher's exact p, single-sided		p = ,0263	
double-sided		p = ,0377	
x^2, McNemar A/D	63,92	p = ,0000	
x^2, McNemar B/C	105,57	p = 0,0000	

RESULTS

Partial anterior open bite was more common in group A: 11 patients (11.82%) including 9 boys (81.82%) and 2 girls (18.18%) as compared to group K: 6 patients (4.2%), including 4 girls (66.67%) and 2 boys (33.33%).

A statistically significant difference (P = 0.267) was observed in the incidence of open bite between children in groups A and K. The results are presented in Tab. I.

In group A, partial anterior open bite was more common in boys as compared to girls.

DISCUSSION

Partial anterior open bite is a type of malocclusion which may develop as a result of long-term habitual oral breathing. The etiology of open bite is multifactorial and includes genetic and environmental factors as well as combinations thereof. Habitual oral breathing may lead to the development of partial anterior open bite. Diagnostic and etiological assessment of malocclusion is required for appropriate orthodontic treatment plan (in cases of dental defects) or multidisciplinary orthodontic/surgical treatment (in cases of gnathic defects).

Masticatory muscles have a great impact on the morphology of the craniofacial complex. Patients with open bite are character-

ized by impaired muscle equilibrium and coordination as well as reduced activity of mandibular elevator muscles [8].

Mattar et al. [11] examined preschool-age children with habitual oral breathing to determine the impact of oral breathing route on craniofacial development. Children with predilection for oral breathing were characterized by vertical direction of facial growth. The authors concluded that concomitance of oral breathing and vertical facial growth have impact on facial development and formation of malocclusions in early childhood.

Urzal et al. [21] assessed the incidence of partial anterior open bite within deciduous or mixed dentition in 1264 children aged 3–12 years prior to orthodontic treatment and determined the causes responsible for this type of malocclusion. The researchers found that habitual oral breathing, as well as pacifier sucking, lip sucking, and tongue dysfunctions, predispose patients to partial anterior open bite in mixed dentition. Authors suggest that the thumb sucking habit should be eliminated early to reduce the risk of malocclusion.

Studies by Malthor [10] and Milanesi [12] confirmed the impact of nasal breathing disturbances on the incidence of malocclusion; however, the patient inclusion criteria used in these studies were quite broad and included not only children with adenoid hypertrophy, but also children with allergic rhinitis and palatine tonsil hypertrophy. Crossbites, overbites, and open bites were observed in these patients [10].

In our study, the inclusion criteria were narrowed down to include only children with nasal breathing disturbances being due to adenoid hypertrophy. This allowed for exceptional objectivization of the assessment of the development of malocclusions in children with adenoid hypertrophy, particularly of the assessment of the incidence of open bite.

Habitual, chronic oral breathing leads to morphological changes within the facial cranium. Pacheco et al. [14] examined a group of 687 children aged 7–12 in whom oral breathing pattern had been observed. Assessed variables included the presence of oral and nasal breathing routes, tonsillar and adenoid hypertrophy, open bite, shape and curvature of hard palate, lip competence, snoring and/or sleep apnea and "nasal obstruction" as reported by the patients". The authors came to the conclusion that prolonged oral breathing in children within the craniofacial development period may affect the facial morphology and predispose patients to vertical growth of inferior segment of the face as well as to narrow and arched hard palate. It may also be the cause of partial anterior open bite and crossbite defects. The aforementioned malocclusions may also be due to the lack of equilibrium between the forces exerted by the tongue, lip, and oral orbicular muscles.

A Korean study assessed adenoid hypertrophy as a risk factor in the development of malocclusion in children [6]. A total of 1083 children with habitual oral breathing, sleep apnea and snoring were qualified for the study. Adenoids were assessed by endoscopy and cephalometric X-rays. A significant correlation was demonstrated between adenoid hypertrophy or allergic rhinitis (AR) and the incidence of dental defects within the masticatory organ. According to the authors, adenoid hypertrophy and ANN were sick factors of partial anterior open bite and crossbite.

In our study, the group of patients with oral breathing route consisted only of children with adenoid hypertrophy. The most common type of malocclusion observed in this group of patients was partial frontal open bite.

Also available are literature reports which do not confirm any negative effects of adenoid hypertrophy on patient's occlusion. Souki et al. [17] carried out a study in a population aged 2–12 years. Our study was conducted in children aged 7–12 years. The age selection criteria were based on the presence of the sixth teeth as the relative alignment of these allowed identification of potential anteroposterior displacements. Moreover, this age range allows for full presentation of the negative impact of disturbed nasal respiration on the development of masticatory organ as manifested by malocclusion [10]. In the study by Souki et al. [17], the study group consisted of children with adenoid hypertrophy, children with tonsillar hypertrophy, and children with allergic rhinitis. Despite the presence of malocclusion defects in children with adenoid hypertrophy and the control group, the authors were unable to confirm any impact of adenoid hypertrophy on the occlusion pattern.

The negative impact of the adenoid on the stomatognathic system was confirmed by Surtel et al. [18]. The disturbance in muscular equilibrium in children chronically breathing through their mouth caused continuously increased tone of oral orbicular muscles and consequently increased the craniovertebral angle, posterior displacement of mandible, and maxillary narrowing. The authors confirmed that these deformations might lead to malocclusion defects such as open bites, overbites, and crossbites [18].

In our study, we also demonstrated the relationship between the gender and the incidence of open bite in children within the study group. Open bite was more common in boys with adenoid hypertrophy (81.82%) as compared to girls with the same disorder (18.18%). The impact of adenoid hypertrophy on the masticatory organs of subjects of different genders was assessed by Nigerian scholars [13]. The outcomes revealed the incidence of crossbites, overbites, and deep bites in the study population. The incidence of open bite was not statistically significant. The authors demonstrated a higher incidence of deep bites in male subjects as compared to female subjects.

On the basis of our own research and the literature reports, it appears that habitual oral breathing due to adenoid hypertrophy is one of the major causes of open bite development. Diagnostic and etiology assessments are of crucial importance and should be carried out in collaboration between pediatric otolaryngologists, pediatricians, and orthodontists.

CONCLUSIONS

Open bite was observed in children presenting with chronic nasal breathing due to adenoid hypertrophy; the disorder was more frequent in male patients.

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