

The Effect of Adenoidectomy on Transnasal Airflow in Children with Hypertrophy of Adenoid Tissue

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Abstract

Background: The aim of this study was to clarify changes of transnasal airflow resulting from adenoidectomy and to assess the effect of surgery depending on adenoid hypertrophy (AH) obstruction grade. **Materials and Methods:** Altogether fifty children having symptoms of nasal obstruction and adenoids were submitted to a rhinomanometric assessment before and after adenoidectomy. At the same time, using the nasal fiberoptic endoscopy, the grade of AH obstruction was determined, according to which the children were divided into four classes. We assessed the change of total transnasal inspiratory airflow and total nasal resistance due to adenoidectomy. **Results:** Values of transnasal airflow and nasal resistance measured in the study group of fifty children were preoperatively 262 mL/s and 0.565 kPa/L/s; postoperatively 288 mL/s and 0.52 kPa/L/s. We have noticed statistically significant increase of the airflow ($P = 0.015$); however, decrease of the resistance ($P = 0.054$) was not significant. In the group of children suffering from the 1st to 2nd grade (29 children) preoperatively measured values presented 280 mL/s and 0.52 kPa/L/s; postoperatively, 276 mL/s and 0.54 kPa/L/s; change of the airflow ($P = 0.634$) and resistance ($P = 0.829$) was not significant. In the study group having the 3rd and 4th grade (21 children), the values indicated preoperatively 240 mL/s and 0.62 kPa/L/s; postoperatively, 340 mL/s and 0.44 kPa/L/s; there were significant airflow increase ($P = 0.012$) and resistance decrease ($P = 0.033$). **Conclusions:** Adenoidectomy significantly increased the airflow; however, we observed the different effect in the group of children with the 1st and 2nd grade compared to the group with the 3rd and 4th grade. A significant increase of the airflow and decrease of the resistance were present only in the group with the 3rd and 4th grade; therefore, the significant reduction of nasal obstruction symptoms might be expected only in this group of patients.

Keywords: Adenoidectomy, adenoids, airway resistance, nasal obstruction

INTRODUCTION

The nasopharyngeal tonsil is physiologically present in children from their birth, and it gradually grows until reaching the age of 5–7 years. The natural enlargement is most significant in 3–5 years. From the age of 8, it gradually regresses, and it can be present approximately until the individual is 15 years old. In a long-term, the nasopharyngeal tonsil can be colonized by pathogenic bacteria, chronic inflammation develops,^[1,2] lymphatic tissue loses its immunologic and protective function,^[3] it becomes hypertrophic, the self-purification function is violated, and adenoid tissue ceases to fulfill its function. When being excessively hypertrophied, we talk about the adenoid hypertrophy (AH).^[4]

The most accurate, effective and reliable diagnostic method enabling a direct view of the AH tissue is nasal fiberoptic endoscopy (NFE).^[5-9] The presence of AH in rhinopharyngeal cavity creates a physical obstacle in the location of posterior choanae and in posterior part of the nasal cavity, which results in decreased nasal cavity airflow and increased airflow resistance.^[10] It leads to nasal obstruction with manifest clinical symptoms such as nasal breathing obstruction, oral breathing, rhinolalia clausa, snoring, sleep-disordered

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Received: 21-12-2015 Revised: 28-09-2016 Accepted: 18-10-2016 Available Online: 05-08-2020

Access this article online

Quick Response Code:



Website:
www.afjpaedsurg.org

DOI:
10.4103/ajps.AJPS_135_15

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How to cite this article: Sojak J, Durdik P, Pecova R. The effect of adenoidectomy on transnasal airflow in children with hypertrophy of adenoid tissue. Afr J Paediatr Surg 2018;15:126-30.

breathing.^[11] Symptoms of nasal airway obstruction can overlap with symptoms of nasal mucosa inflammation, and physical blockage can worsen the rhinosinusitis by blocking the normal nasal airflow which results in accumulation of secretions, nasal cavity, and paranasal sinuses obstruction. The obstruction is given by the grade of AH and can worsen during the infection.^[4]

The rhinomanometry (RMM) represents a semi-objective and quantitative method in assessment of nasal patency. The most frequently used and appropriate method to monitor the changes in nasal patency in different pathological conditions and to observe the effect of therapeutic intervention is active anterior RMM.^[10,12] This technique is based on the simultaneous measurement of nasal airflow and transnasal pressure, which is defined as a difference between the pressure in choanae and the atmosphere. The patency is best characterized by measured airflow at the transnasal pressure of 150 Pa. Such obtained parameters are appropriate for assessment of nasal patency in children with AH.^[10,12]

The main objective of this study was to clarify changes of transnasal airflow in relation with the adenoidectomy (AT) in children with endoscopically verified AH and to consider the effect of surgical treatment on nasal patency according to the grade of AH obstruction.

MATERIALS AND METHODS

This prospective clinical study was approved by the institutional Research Ethics Committee (reference number 1173/2012) and was performed according to the Declaration of Helsinki. Each parent of the observed child was properly informed about the study, about the possibilities of AH treatment and signed an informed consent.

The study included collection of children meeting the following criteria: age 3–15 years, symptoms of nasal obstruction due to AH, objectified the presence of AH stated by NFE examination, good cooperation during the RMM examination, elimination of other possible causes of nasal obstruction (anatomical and congenital abnormalities of nasal cavity and septum, polyps, foreign bodies, infectious, and noninfectious inflammatory problems), absence of signs of respiratory and rhinological complaints which lacked relation with the AH diagnosis, an anamnesis obtained from the parent relating to the respiratory and allergic diseases and their treatment, the children did not take any topical and systemic corticosteroids, antihistamines, antileukotrienes, and decongestants during and minimally 2 weeks before the examination and they did not have any contraindication to endoscopic adenoidectomy in general anesthesia.

The collection of children included fifty Caucasian children (31 boys and 19 girls) aged between 4 and 13 years (mean age 6.4 years; mean height 121 cm). All children who met the given criteria underwent the outpatient ENT examination, during which was the condition of airways objectified by anterior

rhinoscopic examination and NFE in sitting position^[13] by using the flexible NFE. This examination determined the grade of AH obstruction according to criteria stated in [Table 1]^[14] and based on the grade of AH the children were divided into four classes [Table 2].

Subsequently, the parent and the child were instructed about the way of RMM examination. We carried out the RMM examination itself in time interval of 20–22 h before the surgery. Before starting the measurement, the subjects were asked to blow their nose. The measurement was one-off, and within its course, no decongestants and vasoconstrictors were being used as the aim of the examination was to gain current and real image of the nasal patency condition during the measurement as well as the effort to imitate routine outpatient examination. The measurement was realized in all cases by the same physician. Using the method of active anterior RMM (Rhinomanometer Atmos 300, Germany) within the ambulatory form, at the constant room temperature, during quiet breathing with closed mouth, and in the sitting position there were rhinomanometric parameters measured through each nostril separately, and at the same time, a reproducible rhinomanogram was obtained. The measured values contained airflow of the left (Fl.L) and airflow of the right (Fl.R) part of the nasal cavity, total nasal inspiratory airflow (Fl.L + Fl.R); airflow resistance of the left (ResL) and airflow resistance of the right (ResR) parts of the nasal cavity, total nasal resistance in inspirium (ResL + ResR) at the pressure difference of 150 Pa. The data calculation was conditioned by the internal method of data processing, so-called computer-aided RMM according to Prof. Bachert (Rinomanometer Atmos 300, Germany).

Table 1: A grading into four classes of hypertrophied adenoid rhinopharyngeal obstructions

Grade 1	The adenoid tissue occupied only the upper segment in the rhinopharyngeal cavity (<25%), choanal openings are free
Grade 2	The adenoid tissue was confined to the upper half (<50%) of the rhinopharyngeal cavity, choanal openings are free
Grade 3	The adenoid tissue extended over the rhinopharynx (<75%) with obstruction of choanal openings and partial closure of eustachian tube ostium
Grade 4	The adenoid tissue in rhinopharyngeal cavity (>75%) almost totally obstructed choanal openings and eustachian tube ostium

Table 2: Division of children into classes according to the grade of hypertrophied adenoid rhinopharyngeal obstructions

Class	Grade	n	Mean age (years)	Mean height (cm)
1	1	3	6.7	127
2	2	26	6.4	120
3	3	19	6.6	124
4	4	2	4	109

The endoscopic adenoidectomy followed and was carried out in general anesthesia with endotracheal intubation under the endoscope control (Karl Storz rigid endoscope, 4 mm, 70°, Germany). We used McIvor mouth gag to keep the mouth open and subsequently AH were completely removed using Beckmann adenoid curette, St. Clair-Thompson and Jurasz adenoid forceps. Bipolar forceps was used for hemostasis. The AH grade of obstruction was preoperatively verified. Besides the surgery, patients did not undergo any other form of treatment that might have led to the influencing of observed parameters. Adenoidectomy was performed by the same surgeon in all patients and surgeon was not aware of the results.

The control postoperative RMM measurement was done by the same method of out-patient examination within the interval of 3 months after the surgery. The measurement was preceded by NFE examination, which goal was to objectivize condition of the nasal and rhinopharyngeal cavity and to exclude the AH residues.

This study was limited by lower number of patients, especially in the 1st and 4th class. The reason for this is that children with the 1st grade of AH obstruction suffer from symptoms of nasal obstruction very rarely; those symptoms can be due to other pathologies as well. Such children patients are therefore rarely indicated for adenoidectomy. On the other hand in the children patients with the 4th grade of AH obstruction are symptoms of nasal obstruction and concomitant complications related to AH symptoms significant, frequent and annoying, therefore in our regional conditions children usually undergo adenoidectomy yet before the 4th grade of AH obstruction has been reached.

The obtained pre- and post-operative parameters were mutually statistically compared. We assessed the differences of FI.L + FI.R and ResL + ResR at the transnasal pressure of 150 Pa for the collection of all patients (Class 1–4, fifty patients), for the class of 1st and 2nd grade of AH (Class 1 and 2, 29 patients), for the class of 3rd and 4th grade of AH (Class 3 and 4, 21 patients), and individually for the 2nd and 3rd class. Because of low number of patients we did not individually statistically elaborate the 1st and 4th class, since the prerequisites of minimal size of statistical collection necessary for analysis were not met. Before statistical elaboration of the collection of patients, we carried out the normality test of

the separation of measured parameters. The tests confirmed that the separation of measured data cannot be considered to be normal, and therefore in the statistical analysis we used the nonparametric test, particularly Wilcoxon matched-pair test (named also as Mann–Whitney U-test). The results were expressed as median values.

RESULTS

For the collection of all patients (Class 1–4, fifty patients) there were preoperatively measured FI.L + FI.R 262 mL/s and ResL + ResR 0.565 kPa/L/s. Postoperatively, the values presented FI.L + FI.R 288 mL/s and ResL + ResR 0.52 kPa/L/s. At the level of significance 0.05 due to adenoidectomy, we found out a significant increase of FI.L + FI.R ($P = 0.015$), [Figure 1]. The decrease of ResL + ResR was on the border of statistical significance ($P = 0.054$), [Figure 1]. Between the monitored parameters FI.L + FI.R and ResL + ResR, we observed the significant degree of correlation. At the preoperative measurement, there was a correlation coefficient -0.68 between parameters FI.L + FI.R and ResL + ResR, and at the postoperative measurement, the correlation coefficient between FI.L + FI.R and ResL + ResR presented -0.69 .

For the collection of patients with the 1st and 2nd grade of obstruction (Class 1 and 2, 29 patients) there were measured preoperative values of FI.L + FI.R 280 mL/s and ResL + ResR 0.52 kPa/L/s. Postoperative values presented FI.L + FI.R 276 mL/s and ResL + ResR 0.54 kPa/L/s. At the level of significance 0.05 due to adenoidectomy, we did not notice any statistically significant differences between pre- and post-operative values of parameters FI.L + FI.R ($P = 0.634$) and ResL + ResR ($P = 0.829$).

For the collection of patients with 3rd and 4th grade of obstruction (Class 3 and 4, 21 patients) there was measured preoperative value of FI.L + FI.R 240 mL/s and the value of ResL + ResR 0.62 kPa/L/s. Postoperative values presented FI.L + FI.R 340 mL/s and ResL + ResR 0.44 kPa/L/s. At the level of significance 0.05 due to adenoidectomy, we noticed significant increase of FI.L + FI.R ($P = 0.012$) as well as significant decrease of ResL + ResR ($P = 0.033$), [Figure 2].

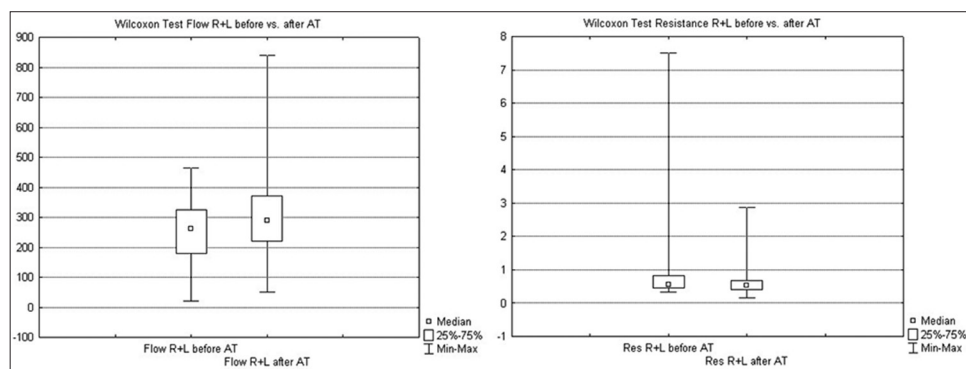


Figure 1: Total nasal inspiratory airflow (flow right + flow left) and total nasal resistance (resistance of the right + resistance of the left) in the collection of all patients (Class 1 to 4, fifty patients) before and after adenoidectomy

In the 2nd class of patients (26 patients), we measured preoperative value of FI.L + FI.R 276 mL/s and the value of ResL + ResR 0.54 kPa/L/s. Postoperatively, there were recorded values FI.L + FI.R 258 mL/s and ResL + ResR 0.575 kPa/L/s. At the level of significance 0.05 due to adenoidectomy, we did not find any statistically significant differences between pre- and post-operative values of parameters FI.L + FI.R ($P = 0.91$) and ResL + ResR ($P = 0.84$).

In the 3rd class of patients (19 patients), there was recorded preoperative value of FI.L + FI.R 244 mL/s and the value of ResL + ResR 0.61 kPa/L/s. Postoperatively, the measured values presented FI.L + FI.R 344 mL/s and ResL + ResR 0.43 kPa/L/s. At the level of significance 0.05 due to adenoidectomy, we detected statistically significant increase of FI.L + FI.R ($P = 0.031$), [Figure 3]. We did not notice any statistically significant differences of ResL + ResR ($P = 0.085$), [Figure 3].

DISCUSSION

In the study, we assessed changes of FI.L + FI.R in relation with the adenoidectomy in children with endoscopically verified AH. The most appropriate RMM parameters for determining the nasal patency are FI.L + FI.R, FI.L, FI.R, ResL + ResR in inspiration at a transnasal pressure of 150 Pa. The variation coefficient for FI.L + FI.R is lower than for the individual sides

separately, and thus this is the most appropriate parameter for assessment of the total nasal patency.^[12] It is necessary to keep in mind that the RMM parameters in children are influenced by their somatic growth. The predicted values of nasal airflow in children increase and the predicted values of resistance decrease by the increasing age^[12,15] and increasing height of the child.^[12] Due to growth, there is anatomical increase in size and diameter of nasal cavity, related to the height similarly in both male and female sexes, while the intensity of growth is the same on both sides of the nasal cavity. Therefore, the values of RMM parameters do not depend on sex of the child, and there is no significant difference between parameters obtained from the right and left nostril.^[10,12] Variability of the RMM parameters measured in the same child in the same conditions within the interval of 20–30 min is lower than 25%.^[12] For the assessment of postoperatively measured parameters, it is proper to wait 3 months in minimum after the treatment, because sooner (1 month after the surgery) the changes of parameters are less significant, probably as a result of healing and presence of edema.^[16]

Adenoidectomy is considered to be the most frequent surgical treatment of children's age.^[16-19] In the collection of all children who underwent adenoidectomy, we observed statistically significant increase of FI.L + FI.R. The obtained findings are in accordance with previous studies, which demonstrated positive effect of adenoidectomy on improved parameters

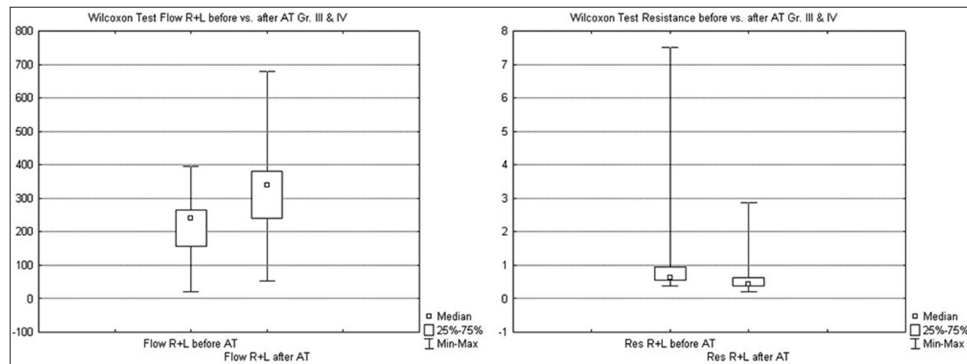


Figure 2: Total nasal inspiratory airflow (flow right + flow left) and total nasal resistance (resistance of the right + resistance of the left) in the collection of patients with 3rd and 4th grade of obstruction (Class 3 and 4, 21 patients) before and after adenoidectomy

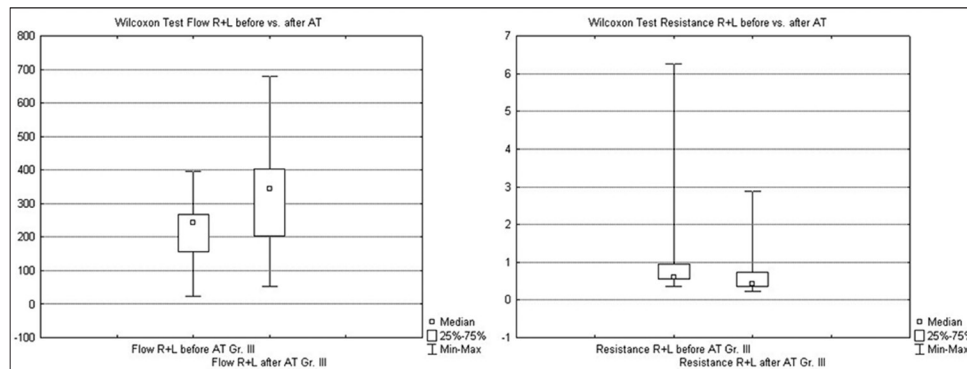


Figure 3: Total nasal inspiratory airflow (flow right + flow left) and total nasal resistance (resistance of the right + resistance of the left) in the collection of patients with 3rd grade of obstruction (Class 3, 19 patients) before and after adenoidectomy

of the nasal patency and reduction of nasal obstruction symptoms.^[10,16,20-22] However, the increase of FI.L + FI.R and decrease of the ResL + ResR was statistically significant only in the group of children with 3rd and 4th grade of AH obstruction.

Reduction of nasal obstruction symptoms due to AH after the adenoidectomy can be according to our findings expected only in children with the 3rd and 4th grade of obstruction. We incline to the conclusion of study according to Cassano *et al.*, wherein children with the 1st and 2nd grade of AH obstruction the adenoidectomy due to isolated nasal obstruction should not be performed. The causes of possible nasal obstructions in children with the 1st and 2nd grade of AH obstruction are usually due to either dysmorphic, allergic, or phlogistic pathologies.^[14]

When indicating the surgery it is necessary to consider except nasal obstruction symptoms also presence of other frequent concomitant complications related to AH as are, for example, oedema of nasal mucosa, chronic runny nose, postnasal drip, throat clearing, chronic cough, chronic and recurrent infections of upper and lower airways, feeding aversion, nausea, obturation of the eustachian tube, hearing loss, recurrent and chronic persistent otitis media, obstructive sleep apnea, nocturesis, inattention, daytime sleepiness. These disorders may be caused by both nasal obstruction, and/or phlogistic problems (adenoiditis).^[14] It is necessary to note that parameters of the nasal patency are significantly influenced by the age of a child and thus is the effect of surgery toward nasal patency most significant in younger children until being 8-year-old.^[10]

CONCLUSIONS

We have confirmed that the adenoidectomy increased nasal patency in paediatric patients suffering from nasal obstruction due to AH, in which we postoperatively observed significant increase of FI.L + FI.R. However, we have noticed a different result of adenoidectomy in the collection of children with 1st and 2nd obstruction grade comparing to the collection of children with the 3rd and 4th obstruction grade. Only in the group of children with 3rd and 4th obstruction grade was in relation to the adenoidectomy significant increase of FI.L + FI.R and decrease of ResL + ResR.

The surgery showed to be an effective and justified treatment of the nasal patency, what supports its meaning and dominant position among surgical treatments of children. Although significant improvement of nasal patency and reduction of nasal obstruction symptoms due to adenoidectomy can be expected only in children suffering from the 3rd and 4th grade of AH obstruction.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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