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Impact of Adenoidectomy on Bronchial Asthma in Children

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Abstract
Backgoudn: asthma is one of the most prevalent chronic diseases of childhood, data from the American national health interview survey revealed the prevalence in children 14 years of age and younger to be 9.0%.
Objictive: the aim of this work is to assess the effect of adenoidectomy on bronchial asthma. The conclusions of this study may aid in counseling patients and their families regarding the impact of surgical intervention on the modulation of asthma symptoms.
Patients and Methods: this was a prospective case series study. Patients were selected from those attending asthma pediatric clinic at Al-Azhar University Hospitals (Sayed Galal and Al-Hussain hospitals). After exclusion and inclusion criteria were applied, 50 children with diagnosis of chronic adenotonsillitis associated with bronchial asthma were enrolled in the study.
Results: there was a significant improvement of asthma control test and SN-5 questionnaire results in both urban and rural inhabitants comparing preoperative and postoperative state. There was a non-significant difference between urban and rural residence regarding improvement of bronchial asthma after. There was a significant improvement in both sexes regarding asthma control test and SN-5 questionnaire results comparing preoperative and postoperative state. On the other hand, there was a non-significant difference between male and female gender regarding such improvement after AT. **Conclusion:** adenotonsillectomy in asthmatic patients with chronic adenotonsillitis may lead to significant improvement in asthma symptoms control and most of the patients are able to eliminate their medications and improve quality of their life style.
Keywords: adenoidectomy, bronchial Asthma, children

INTRODUCTION

Hypertrophy of the adenoid tissue (AH) is a common morbidity of childhood which is associated with nasal obstruction, snoring, sleep apnea, recurrent otitis media, recurrent rhinosinusitis infections, and craniofacial anomalies **(1).**

The most common cause of upper airway obstruction in children and adolescents is adenoid hypertrophy (AH) which is a natural response to increased immunologic activity in early life **(2).**

Excess of lymphatic tissue filling a disproportionate volume of the upper airway is observed especially in pre-school children. Adenotonsillar hypertrophy is the primary cause of sleep-related breathing disorders (SRBD). Patients suffering from SRBD present snoring, mouth breathing, pauses and stops in breathing, wheezing, enuresis, ineffective sleep. Complications of sleep apnea may manifest as pulmonary hypertension and right ventricle hypertrophy (cor pulmonale) **(3).**

Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation **(4).**

Others have argued that a common mechanism may cause both upper and lower airway disease, and that children who have symptoms severe enough to warrant adenotonsillectomy are also at increased risk of asthma and atopic disease **(5).**

The unified airway suggests a common mechanism behind the pathophysiology of asthma and rhinitis. Inflammation associated with rhinitis may cause the upregulation of inflammatory mediators leading to changes in lower airways. Studies have suggested that multiple viral infections introduce inflammatory mediators leaving an immune "memory effect". This memory effect may cause an exacerbated response to future viral infections **(6).**

Childhood asthma and obstructive sleep apnea (OSA), both disorders of airway inflammation, were associated in recent observational studies. Although childhood OSA is effectively treated by adenotonsillectomy (AT), it remains unclear whether adenotonsillectomy also improves childhood asthma or not **(7).**

AIM OF THE WORK

The aim of this work is to assess the effect of adenoidectomy on bronchial asthma. The conclusions of this study may aid in counseling patients and their families regarding the impact of surgical intervention on the modulation of asthma symptoms.

PATIENTS AND METHODS

Type of study: Prospective cohort study.
Patients:

- This study was conducted over 50 children aged 2.5-13 years suffering from mild presistent bronchial asthma and adenoid hypertrophy.

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- Patients was selected from those attending Pediatric and E.N.T clinics at Al-Azhar University Hospitals (Sayed Galal and Al-Hussain hospitals).

Inclusion criteria:

1- Fifty patients previously diagnosed as bronchial asthma.
2- Clinical diagnosis of chronic adenoid hypertrophy.
3- Patients aged 2.5-13 years both males and females.
4- Patients currently diagnosed as adenoid hypertrophy.

Exclusion criteria:

1- Patients < 2.5 years and > 13 years.
2- Patients with other chest problems e.g. cystic fibrosis, bronchiectasis.
3- Craniofacial abnormalities e.g. cleft palate.
4- Associated cardiac disease e.g. ASD, VSD.
5- Patients with other nasal problems e.g. nasal polyp, deviated nasal septum.

Ethical approval and written informed consent:

An approval of the study was obtained from Al-Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Methods: patients were devided into 2 groups:

a. below 5 years.
b. above 5 years.

Both groups will be subjected to the following:

1- Full history taking.
2- Full E.N.T and chest examination.
3- X-ray skull and nasopharynx soft tissue window lateral view.
4- Full preoperative laboratory assessment (CBC, PT, PTT, INR).
5- Postoperative follow up by:
   a. GINA asthma assessment control questionnaire.
   b. Sinus and nasal quality of life (SN-5) questionnaire.
   c. Patient frequent use of treatment or hospital admission.

Preoperative assessment

- **History: including:** Personal data, present history, past history, recording of the current asthma control status using the asthma control survey.
- **Examination: including:** General examination and local examination.

1- Investigations: Complete blood picture, Prothrombin time and concentration and INR.

Peri-operative anesthetic preparation:

1- A serene atmosphere is guaranteed to avoid as much as possible all potential stressful events since it is recognized that the psychological component of asthma in the child may influence the clinical course and the recurrence of acute attacks[(4)].
2- It is important to continue the usual inhalational therapy until the day of surgery. The use of inhaled β2 agonists (salbutamol) prior to the theater is useful to prevent the respiratory resistance increase observed after endotracheal intubation under sevoflurane [(8)].
3- The control of post-operative pain has a key role in the postoperative management of the child [(8)].

Operative Intervention

- All patients underwent adenotonsillectomy operation after taking written consent from the child's caregiver.
- Under general anaethesia (GA), and after administerion via an oral endotracheal tube (ET), adenotonsillectomy was done using cold dissection technique which is the commonest method of tonsillectomy, as well as its advantages in less post-operative pain and infection [(4)].
- **Postoperatively,** patients who underwent adenoidectomy were monitored carefully with a view to early detection of any hemorrhage.
- This involved regular measurements of pulse rate and observation for excessive swallowing or any frank bleeding from mouth or nose.
- After tonsillectomy patients should be encouraged to eat a normal diet.
- Asthma controller medications are continued, and then stopped gradually according to the follow up with the pediatric pulmonologist.

Postoperative Assessment:

One month after doing the adenotonsillectomy operation, patients were re-assessed using the Asthma control survey and Sino-nasal questionnaire to re-evaluate the current asthma condition. We have set up the follow up period to 3 months as this is the half-life of most of mediators of bronchial asthma reactions.

Assessing asthma symptom control:

Defining satisfactory symptom control in children 5 years and younger is problematic. Health care providers are almost entirely dependent on the reports of family members, who may be unaware either of how often the child has experienced asthma symptoms, or that their respiratory symptoms represent uncontrolled asthma. a working schema for assessing asthma control in children either 5 years or younger or more than 5 years of age, based on current expert opinion. It incorporates assessment of symptoms; the child's level of activity and their need for reliever/rescue treatment; and assessment of risk factors for adverse outcomes [(4)].

There is additional assessment for future risk for poor asthma outcome which is beyond the scope of our study, and so it wasn't included in the assessment of our patients.

Then in the current study, a new categorization for detection of the improvement of patients was used. Patients were divided into the following categories:

1-No change: Patient remained in the same category of asthma control postoperatively.

2-Improvement: Patients who moved from one category to the better one.

3-High improvement: Patients who changed from being poorly controlled to be well controlled.

4-Worsening: Patients who moved from one category to a worse category after operation.

Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc, Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Chi-square (x^2) test of significance was used in order to compare proportions between qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:
- Probability (P-value)
  - P-value <0.05 was considered significant.
  - P-value <0.001 was considered as highly significant.
  - P-value >0.05 was considered insignificant.

RESULTS

Table (1): Demographic data distribution of the study group.

Demographic data	Total (n=50)
Age (years)	
<5 years	23 (46%)
>5 years	27 (54%)
Range [Mean ± SD]	3.4-12 [5.92±2.24]
Sex	
Male	22 (44%)
Female	28 (56%)
Residence	
Urban	25 (50%)
Rural	25 (50%)

This table shows that the <5 years 23(46%) and >5 years 27(54%) of age, also males 22(44%) and females 28(56%), while urban 25(50%) and rural 25(50%) of residence.

According to pre-operative asthma control test results patients were subdivided to three groups ***well controlled*** with score (0) and this group included 8 patients (18%) and ***moderate controlled*** with score (1-2) and this group included 33 patients (66%) and ***poorly controlled*** with score (3-4) included 9 patients (16%) **Table 2**.

Table (2): Asthma control test (ACT) levels distribution of the study group.

ACT	Total (n=50)
Pre-operative ACT	
Poorly controlled	9 (16%)
Moderately controlled	33 (66%)
Well controlled	8 (18%)
Range [Mean±SD]	0-4 [2 (1)
Post-operative ACT	
Poorly controlled	4 (8%)
Moderately controlled	10 (20%)
Well controlled	36 (72%)
Range [Mean±SD]	0-4 [1 (1)

Table (2) shows highly statistically significant improvement in post-operative results as compared to preoperative regarding Asthma Control Test (P<0.001).

Table (3): Comparison between preoperative and postoperative according to ACT.

ACT	Pre-operative ACT *(n=50)*	Post-operative ACT *(n=50)*	x2	p-value
Poorly controlled	9 (18%)	4 (8%)	32.044	<0.001 **
Moderately controlled	33 (66%)	10 (20%)		
Well controlled	8 (16%)	36 (72%)		

***p-value <0.001 HS*

Table (3) shows statistically significant difference in both age categories (below and above 5 years) regarding asthma control test results comparing preoperative and post-operative state. This table shows no statistically significant difference between both genders males and females regarding improvement of asthma control test results after adeno-tonsillectomy.

Table (4): Comparison between preoperative and postoperative SN-5 score regarding patients age (years).

Age (years)	SN-5 score	Pre-operative SN-5 score *(n=50)*	Post -operative SN-5 score *(n=50)*	x2	p-value
<5 years	Good Asthma Control	0 (0%)	18 (36%)	26.377	<0.001**
	Poor Asthma Control	23 (46%)	5 (10%)		
>5 years	Good Asthma Control	0 (0%)	22 (44%)	33.827	<0.001**
	Poor Asthma Control	27 (54%)	5 (10%)		

***p-value <0.001 HS.* This table shows statistically significant difference between preoperative and postoperative SN-5 score regarding patient's age (years).

Table (5): Comparison between preoperative and postoperative SN-5 score regarding patients' sex.

Sex	SN-5 score	Pre-operative SN-5 score *(n=50)*	Post -operative SN-5 score *(n=50)*	x2	p-value
Male	Good Asthma Control	0 (0%)	16 (32%)	22.098	<0.001**
	Poor Asthma Control	22 (44%)	6 (12%)		
Female	Good Asthma Control	0 (0%)	24 (48%)	38.572	<0.001**
	Poor Asthma Control	28 (56%)	4 (8%)		

***p-value <0.001 HS*

This table shows statistically significant difference between preoperative and postoperative SN-5 score regarding patient's sex.

Table (6): Comparison between preoperative and postoperative SN-5 score regarding patient's residence.

Residence	SN-5 score	Pre-operative SN-5 score *(n=50)*	Post -operative SN-5 score *(n=50)*	x2	p-value
Urban	Good Asthma Control	0 (0%)	19 (38%)	27.504	<0.001**
	Poor Asthma Control	25 (50%)	6 (12%)		
Rural	Good Asthma Control	0 (0%)	21 (42%)	32.841	<0.001**
	Poor Asthma Control	25 (50%)	4 (8%)		

***p-value <0.001 HS*

This table shows statistically significant difference between preoperative and postoperative SN-5 score regarding patient's residence.

Table (7): Comparison between preoperative and postoperative according to SN-5 score.

SN-5 score	Pre-operative SN-5 score	Post-operative SN-5 score	x2	p-value
Poor Asthma Control	50 (100%)	10 (20%)	63.271	<0.001**
Good Asthma Control	0 (0%)	40 (80%)		
Mean±SD	2.96±0.37	5.55±1.59		

***p-value <0.001 HS*

This table shows statistically significant difference between pre and postoperative according to SN-5 score.

Table (8): Relation between frequent use of asthma medications with demographic data.

	Demographic data	Frequent Use of Asthma Medications				Chi-square test	
		Decreased *(n=38)*		No change *(n=12)*		x2	p-value
		No.	%	No.	%		
Age (years)	<5 years	18	47.4%	5	41.7%	0.119	0.73
	>5 years	20	52.6%	7	58.3%		
Sex	Male	16	42.1%	6	50.0%	0.231	0.631
	Female	22	57.9%	6	50.0%		
Residence	Urban	18	47.4%	7	58.3%	0.439	0.508
	Rural	20	52.6%	5	41.7%		

p-value >0.05 NS;

This table shows no statistically significant relation between frequent use of asthma medications with demographic data.

Table (9): Relation between postoperative hospital visits with demographic data.

	Demographic data	Post-Operative Hospital Visits				Chi-square test	
		Decreased *(n=39)*		No change *(n=11)*		x2	p-value
		No.	%	No.	%		
Age (years)	<5 years	19	48.7%	4	36.4%	0.527	0.468
	>5 years	20	51.3%	7	63.6%		
Sex	Male	16	41.0%	6	54.5%	0.636	0.425
	Female	23	59.0%	5	45.5%		
Residence	Urban	19	48.7%	6	54.5%	0.117	0.733
	Rural	20	51.3%	5	45.5%		

p-value >0.05 NS;

This table shows no statistically significant relation between postoperative hospital visits with demographic data.

DISCUSSION

We have noticed controversy in literature whether AT has a beneficial effect in controlling manifestations of bronchial asthma in children or not, thus clarifying the nature of the relationship between AT and control of asthma through a prospective study was of a great importance and would have therapeutic implication.

In the current case series prospective study, we aimed to detect the impact of adenoidectomy operation on the control of bronchial asthma in pediatric population who suffered both chronic adenotonsillitis and bronchial asthma. Fifty (50) patients were included in the present study after applying inclusion and exclusion criteria.

All patients were assessed for the level of asthma control just before performing AT operation using the 4 items Asthma Control Survey adopted by **GINA association in** [(4)]. Also assessed by SN-5 questionnaire and they were re-evaluated 3 months later for detection of changes in asthma control level using the same questionnaires.

In the current study, patients were equally distributed between urban and rural residence with 25 patients in each category (50% for each). There was a significant improvement of asthma control test results in both urban and rural inhabitants comparing preoperative and postoperative state. (P value< 0.01). There was a non-significant difference between urban and rural residence regarding degree of improvement of bronchial asthma after adeno-tonsillectomy (p =0.44), and this matches the findings of the epidemiological study conducted by **Abdallah *et al.*** [(9)] which aimed for determination of the prevalence and risk factors of asthma among preparatory school children in Assiut district, in Upper Egypt through a cross sectional study. They found that there was no significant difference between urban and rural areas (P = 0.075) regarding prevalence of bronchial asthma.

Also, **Zedan *et al.*** [(10)] studied the prevalence of bronchial asthma among Egyptian school children, and the study was applied on using an Arabic translation of the validated ISAAC questionnaire and found that of the 2720 positively responding subjects, 209 fitted the diagnosis of asthma with an overall prevalence of 7.7% (8% in urban and 7% in rural areas), which is considered a non-significant difference.

This non-significant difference between the rural and urban residence may be explained by presence of specific risk factors for development of asthma in both residencies such as dust and fumes and air pollution in the urban community, and pollens and farming environment in rural residency. Moreover, these factors compensate for each other making a nearly similar risk for bronchial asthma in both residencies.

The current study included 22 males (44%) and 28 females (56%), with a male to female ratio of 1:1.3. There was a significant improvement in both sexes regarding asthma control test results comparing preoperative and postoperative state (P value<0.0l). On the other hand, there was a non-significant difference between male and female gender regarding such improvement after AT (p = 0.19).

Kynvk *et al.* [(11)] studied the relation between sex and asthma and they found that there is female predominance associated with increased incidence of asthma. Data demonstrate that asthmatic females have a poorer quality of life and increased utilization of healthcare compared to their male counterparts despite similar medical treatment and baseline pulmonary function. Research continues to explore hypotheses for these differences including the potential influences of the female sex hormones, altered perception of airflow obstruction, increased bronchial hyper-responsiveness, and medication compliance and technique. However, no single explanation has been able to fully explain the disparities. There is still a controversy in such relation between sex and development of asthma or even control of asthma status till the moment.

In the current study, the age of the selected cases ranged between 2.5 and 13 years with mean 5.93±2.93 SD. Patients were distributed between two age categories: 5 years or younger and this group included 23 patients (46%) and more than 5 years' age group which included 27 patients (54%). There was a significant improvement in both age categories regarding asthma control test results and SN-5 questionnaire comparing preoperative and postoperative state. (P value =0.001) whether 5 years or younger age group, or more than 5 years of age group

On the other hand, there was a significant difference between age 5 years or younger and age more than 5 years regarding such improvement after AT (p =0.02), in the form of significant difference and high improvement in the status of asthma control, as 10 patients out of do have moved from the category of poorly controlled to the category of well controlled asthma in the age group (5 years or younger). But only one patient moved from poorly controlled to well controlled category in the age group older than 5 years of age. Thus, earlier AT may help to control asthma in children suffering from both asthma and adenotonsillitis. This may be explained by the fact that most of asthmatic children of the 5 years and younger group are non-atopic wheezers or transient wheezers [(12)].

In such cases, recurrent upper respiratory tract infections play a great role in development of asthma and wheezing; thus, elimination of the source of infection by AT improves patient's asthma control. On the other hand, older children are mostly atopic wheezers, which is a more stable type of asthma and needs more control; as well as possessing a genetic background for asthma [(12)].

In the current study, there was a highly significant difference between preoperative and postoperative condition regarding asthma control test results (P <0.01) which was in the form of overall improvement of asthma control. This matches the results reported by **Busino *et al.*** [13] who studied all children who underwent AT at their institution from 2002-2007. Out of the 560 charts reviewed, 93 of the patients were asthmatic as diagnosed by the pediatric pulmonologist. Outcome measures of asthma control were analyzed one year preoperatively and one year postoperatively and included: hospital visits, systemic steroid use, asthma medication use and asthma control test scores. There was a statistically significant improvement in postoperative asthma severity in all measures including mean hospital visits, systemic steroid administration, asthma medication use, and childhood asthma control test scores (p<0.01).

Also, **Pussens *et al.*** [14] studied 11.114 subjects aged 0-15 years' old who underwent AT. They compared the use of respiratory medication 12 months before and 12 months after AT. They found that out of 11.114 subjects, 4.654 received at least one prescription for respiratory medication in the year before and/or after AT. In this subgroup, the use of respiratory medications significantly (P < 0.001) decreased with 32% in the year after surgery.

On a larger scale, **Bhattacharjee *et al.*** [7] used the 2003-2010 Market Scan database and identified 13,506 children with asthma in the United States who underwent AT. Asthma outcomes during 1-year preceding AT were compared to those during 1 year following ATE. In addition, 27,012 age. sex, and geographically matched children with asthma without ATE were included to examine asthma outcomes among children without known adenotonsillar tissue morbidity. They found that ATE was associated with significant reductions in acute asthma exacerbation (AAE) (p<0.0001), acute status asthmaticus **(ASA)** (p<0.0001). The frequency of asthma-related emergency room visits (ARERs) (p< 0.0001). Moreover, ATE was associated with significant reductions in most asthma prescription refills, including bronchodilators (p < 0.001), inhaled corticosteroids (p<0.001), leukotriene receptor antagonists (p,0.001), and systemic corticosteroids (p,0.001). In contrast, there were no significant reductions in these outcomes in children with asthma who did not undergo **ATE** over an overlapping follow-up period.

In addition, 27,012 age, sex, and geographically matched children with asthma without AT were included to examine asthma outcomes among children without known adenotonsillar tissue morbidity. They found that ATE was associated with significant reductions in acute asthma exacerbation (AAE) (p<0.0001), acute status asthmaticus (ASA) (p<0.0001). The frequency of asthma-related emergency room visits (ARERs) (p< 0.0001).

Moreover, AT was associated with significant reductions in most asthma prescription refills, including bronchodilators (p < 0.001), inhaled corticosteroids (p<0.001), leukotriene receptor antagonists (p,0.001), and systemic corticosteroids (p,0.001). In contrast, there were no significant reductions in these outcomes in children with asthma who did not undergo ATE over an overlapping follow-up period. Also, **Paranik and El-Sheikh** [15] conducted a prospective study for two years on twenty-seven children (6-16 years) who were asthmatic and diagnosed by the pediatrician with history of recurrent adenotonsillitis. These children had lung function tests (FEV1 and FVC) preoperatively and postoperatively six weeks following the operation.

Tonsillar/adenoidal tissues were subjected to histological examination, the symptoms and use of their medication postoperatively were compared preoperatively. Postoperative evaluation proved that symptoms improved in 20 patients and 19 patients were able to eliminate all of their medications; 20 patients had improvements in their lung function tests. Histology of all the specimens proved to be chronic inflammation.

Our study is not the first to pay attention to the relation of SN-5 scoring with ACT questionnaires and bronchial asthma. **Sasikumar *et al.*** [16] has revealed that SN-5 can be used as an objective measure to adequately identify upper airway symptoms in the pediatric asthma population, as this does not currently exist. Also, recommended general pediatric providers to add SN-5 to questionnaires used in daily practice, like ACT and TRACK for evaluation of upper airway comorbidity affecting asthma control, and should be used to help initiate and monitor CRS symptoms longitudinally. In pediatric patients with positive SN-5 questionnaires, medical management should be initiated with further referral to otolaryngologist and allergy specialist in instances where symptoms persist. From a practical standpoint, SN-5 can be a less expensive indicator to appropriately start rhinosinusitis treatment and minimizing asthma therapies, with referral to subspecialists for those patients in whom SN-5 scoring does not improve on reassessment after initiation of CRS medications.

CONCLUSION AND RECOMMENDATIONS

1- Adenotonsillectomy in asthmatic patients with chronic adenotonsillitis leads to significant improvement in asthma symptoms control and most of the patients are able to eliminate their medications and improve their life style.
2- Adenotonsillectomy in asthmatic patients suffering from obstructive sleep apnea leads to significant improvement in obstructive manifestations, quality of sleep and asthma symptoms control

3- Earlier adenotonsillectomy before school age in asthmatic children with chronic adenotonsillitis may help to improve asthma control.

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