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Impact of Adenotonsilar Hypertrophy on Physical Growth and Bone Age in Egyptian Children

[1]*Sahar A. El Masry,* [2]*Tharwat Deraz,* [2]*Terez B. Kamel,*
[1]*Sanaa Kamal Mohamed,* [1]*Mohamed Shaker*[1] *and Dina Ali*

[1]Department of Biological Anthropology, National Research Centre, Cairo, Egypt
[2]Pediatric Department, Faculty of Medicine, Ain Shams University, Egypt

Abstract: *Objectives:* Evaluating the impact of adenotonsilar hypertrophy on physical growth and bone age of Egyptian children. *Subjects and Methods:* The present study included 30 children aged from 3 to 7 years old ± 6 months, of both sexes, who had chronic recurrent hypertrophic adenotonsillitis accompanied by obstructive symptoms such as night-time snoring, apneas, or difficult breathing and were referred from the Pediatric to the Otorhinolaryngology outpatient clinic of Ain Shams University hospitals, during the period from 6/2010 to 3/2011. On the attempts to evaluate the effect of the chronic Adenotonsillar hypertrophy on physical growth, the anthropometric measurements were performed and the mean values were subsequently used. Results revealed that in Adenotonsilar hypertrophy was more prominent among girls (53.33%) than among boys (46.67%). Grade 3 is the most frequent grade, with insignificant sex difference. The bone age was delayed than the chronological age in both sexes (1.05 years for boys and 0.44years for girls) with statistical significant difference in total sample and boys only. There were insignificant sex differences in all the anthropometric measurements under study and frequency of growth failure. Insignificant statistical difference was detected between children with grades 1and 2 and children with grades 3 and 4 of adenoid hypertrophy regarding the bone age and all the anthropometric measurements. One third of the studied children were suffering from stunting. *Conclusion:* Adenotonsillar hypertrophy (ATH) had insignificant effect on the anthropometric measurements of young children. However, it causes significant delayed bone age mainly in males and stunting with insignificant sex differences.

Key words: Adenotonsillar Hypertrophy Grade · Growth · Bone Age · Children

INTRODUCTION

Growth evaluation; height and weight determinations; remains one of the most useful indices for public health and economic well being; specifically in developing countries and countries in transition [1].Growth should be monitored sequentially, as it is an important tool in the early detection of chronic disease in children [2]. Some of the physical changes commonly found in children with upper airway obstruction include the increase in chest dimensions in order to make inspiration easier in the different skull position [3].

Adenotonsillar hypertrophy (ATH) is a very frequently encountered disease in children [4, 5]. It is the most common cause of chronic upper airway obstruction in them. It is also associated with growth delay in children [6- 8*)*, that gets worse when associated with obstructive sleep apnea and hypoapnea (OSAH). Palatine tonsillar hypertrophy corresponds to approximately 75% of OSAH in children and within this group 1% to 46% may show growth delays [9].

Growth failure is seen in a variety of diseases and is usually associated with a delay in skeletal or bone age which should be distinguished from genetic short stature and constitutional delay in growth [2].

Bone age; the most common measure for biological maturation of the growing human; is derived from the examination of successive stages of skeletal development,

Correspnding Author: Sahar Elmasry, Department of Biological Anthropology, National Research Centre, Cairo, Egypt.

as viewed in left hand-wrist radiographs. This technique; used by pediatricians, orthopedic surgeons, physical anthropologists and all those interested in the study of human growth; is the only available indicator of development that spans the entire growth period, from birth to maturity. In children with chronic disease and growth failure, bone age can be delayed by more than 2 years compared with that of a normal child in whom the bone age should correlate with the chronological age [10].

So, this study was aimed to assess the relationship between severity of chronic adenotonsillar hypertrophy and its impact on physical growth and bone age among Egyptian children.

MATERIALS AND METHODS

Subjects: Thirty patients of both sexes (boys and girls) suffering from chronic adenotonsillar hypertrophy were included in this cross sectional study. Their age ranged between 3-7 years ± 6 months. They were referred from the Pediatric Dept.; children with a diagnoses of hypertrophic palatine and/or pharyngeal tonsils; to the Otorhinolaryngology outpatients' clinic of Ain Shams University hospitals, during the period from 6/2011 to 3/ 2012. Children were excluded if they have acute tonsillitis, any chronic lung diseases as bronchial asthma, any associated chronic systemic illness (e.g., heart diseases, diabetes mellitus), neurological disease or obese children (BMI >95^{th} percentile of the reference population). Written informed consent was obtained from the parents after explanation of the aim of the study and its benefits for their children and other children who have the same disease. Also, approval of the "Ethical Committee of the National Research Centre" was obtained.

Methods: All patients subjected to full history taking, throat examination, anthropometric and radiological assessment.

Full History Taking: A simple questionnaire was directed to the parents, including personal data, the presence or absence of consanguinity, the symptoms of sleep disordered breathing, the medical history of the child with special emphasis on any chronic condition or long term systemic treatment that could affect their physical growth.

Throat Examination: Nasopharyngeal examination of the nose, mouth and tonsils was observed on direct visual examination. The degree of upper-airway obstruction is graded clinically in each child by direct visual examination of the nasopharynx according to the Brodsky scale [11, 12]:

- Grade I: tonsils in the tonsillar fossa, barely visible behind the anterior pillars.
- Grade II: tonsils easily visible behind the anterior pillars.
- Grade III: tonsils extending three-quarters of the way to midline.
- Grade IV: tonsils completely obstructing the airway.

Anthropometric Measurement: Anthropometrical assessment (body weight, height and chest circumference) were performed, using standardized equipments and following the recommendations of the International Biological Program [13]. Three consecutive measurements were taken and when the differences between the readings were acceptable the mean was recorded. Height (cm) was measured in the upright position to the nearest 1mm via Holtain portable anthropometer. Body weight (kg) was measured on a Seca scale Balance with a precision of 100 g. BMI was calculated as body weight divided by height squared (kg/m^2). Chest circumference was measured by a flexible, non stretchable measuring plastic tape.It was measured to the nearest 0.1 cm, with the child in the standing position, at the level of the nipples, at the end of a full expiration. Contact with the skin should be continuous along the tape but the skin should not be pressed inwards. The subject stands erect looking straight ahead. The shoulders and upper extremities are relaxed.

Radiological Assessment

X-ray Left Hand for Bone Age: Hand is rested on the cassette in postro-anterior position with the central ray perpendicular to the plain of film and centered halfway between tips of fingers and distal end of radius. The patient's film is compared with the standard of the same gender and nearest chronological age. It is next compared with the adjacent standards, both older and younger than the one that is of the next choronologic age. For more detailed comparison, selection of the standard that is superficially appears to most closely resemble the patient's film [14].

Skull X-ray Lateral View: It was done for radiological grading of adenotonsillar hypertrophy. Lateral cephalometric radiographs were obtained with the subject in the erect position, with the teeth in occlusion and the lips in repose during film exposure. Adenoid hypertrophy is staged radio-graphically by lateral neck x-rays according to severity of airway obstruction using the Brodsky scale [11, 12] as follow:

- Grade I: <25% airway obstruction
- Grade II: 25-50%
- Grade III: 51-75%.
- Grade IV: > 75%.

Statistical Analysis: Statistical evaluation of the results was performed with the SPSS computer program, version 16.0. Data were reported as frequency distribution (number and percentage) for the non-parametric data, mean and standard deviation for the parametric data. Student's independent t test (for the parametric data) and Chi –square test (for the non-parametric data) were used to examine the sex differences. Paired t-test was used to compare between the bone age and chronological age. The criteria for growth failure were weight and\or height being less than the 5th percentile for age [15] (Bonuck *et al*., 2006). The level of significance was set at a probability of less than 5% ($p<0.05$).

RESULTS

This study revealed that adenotonsilar hypertrophy was more prominent among girls (53.33%) than among boys (46.67%). There were (10%) children with grade II tonsils, (73.33%) with grade III and (16.67%) with grade IV, while (6.67%) had grade I adenoid, (26.67) grade II, (43.33) grade III and (23.33%) grade IV. Grading of tonsils and adenoid revealed that grade 3 is the most frequent grade among boys and girls. There was insignificant sex difference regarding the grading of tonsils or adenoid hypertrophy (Table 1).

The average age for the patients included in the study was 3years to 7 years with a mean age was (4.93± 1.36) year's. Their bone age ranged from 1.70 to 7.50 years with a mean of bone age was (4.21±1.71) years. The bone age of the studied children was delayed than their chronological age in both sexes (1.05 years for boys and 0.44years for girls) with statistical significant difference in total sample and boys only where delay was more pronounced (Table 2).

Comparison of the anthropometric characteristics by sex revealed that although girls were older than boys, but the differences were significant only for bone age and not for chronological age. There were insignificant sex differences in all the anthropometric measurements under study. However, girls were heavier, shorter and had higher values of BMI, BMI-z score, chest circumference, skinfold thickness at triceps and subscapular areas (Table 3).

Table (4) shows insignificant statistical difference between children with grades 1and 2 and children with grades 3 and 4 of adenoid hypertrophy regarding the bone age and all the anthropometric measurements.

Table (5) illustrates sex differences in the frequency (%) of children suffering from growth failure (= 2 SD). The growth failure rate for weight was 16.67% under weight (14.29% boys and 18.75% girls), 33.33% stunting (21.43% boys and 43.75% girls) and 6.67% under nourished according to BMI Z score. There was statistical insignificant sex difference. It was obvious that one third of the studied children suffering from stunting.

Table 1: Frequency distribution of grading of tonsils and adenoid hypertrophy by sex

Variables		Total		Boys (N=14)		Girls(N=16)		Chi-square	
		N	%	N	%	N	%	X^2	P-value
Tonsils	Grade 1	0	0.00	0	0.00	0	0.00		
	Grade 2	3	10.00	0	0.00	3	18.80	4.870	0.087
	Grade 3	22	73.30	10	71.40	12	75.00		
	Grade 4	5	16.70	4	28.60	1	6.20		
Adenoid	Grade 1	2	6.70	2	14.30	0	0.0	5.083	0.165
	Grade 2	8	26.70	4	28.60	4	25.00		
	Grade 3	13	43.30	6	42.90	7	43.80		
	Grade 4	7	23.30	2	14.30	5	31.20		

Table 2: Statistical comparison between the chronological age and bone age in boys and girls

	Age (years)	Bone Age(years)	Paired t-test	
	Mean ± SD	Mean ± SD	T	P
Total	4.93+1.36	4.21+1.71	3.117	0.004*
Boys	4.61 + 1.47	3.56 + 1.29	3.120	0.008*
Girls	5.22 + 1.22	4.78 + 1.87	1.405	0.150

Table 3: Statistical comparison between boys and girls as regards Anthropometric characteristics

	Boys	Girls		
	Mean ± SD	Mean ± SD	t-value	*P*
Age (years)	4.61 ± 1.47	5.22 ± 1.22	- 1.24	0.224
Bone age	3.56 ± 1.29	4.78 ± 1.87	- 2.10	0.046*
Anthropometry:				
Weight (Kg)	17.39 ± 4.15	20.25 ± 6.02	- 1.49	0.147
Weight for age z score	-0.34 ± 1.39	0.15 ± 1.58	- 0.89	0.377
Height (cm)	1.05 ± 10.82	1.02 ± 15.15	0.44	0.664
Height for age z score	-0.38 ± 0.99	-1.69 ± 2.72	1.71	0.099
BMI(Kg/m²)	15.81±2.36	20.69 ± 10.87	- 1.75	0.099
BMI for age z score	-0.33 ± 2.31	0.98 ± 1.74	-1.77	0.088
Chest circumference(cm)	55.57 ± 4.11	56.59 ± 4.97	- 0.61	0.548

Table 4: Comparison of the anthropometric measurements between children with grades 1and 2 and children with grades 3 and 4 of adenoid hypertrophy

	Adenoid Grade			
	Grade 1+2	Grade 3+4	T-test	
	Mean ± SD	Mean ± SD	T	P-value
Age (years)	4.850 ± 1.248	4.975 ± 1.437	-0.234	0.817
Bone age (years)	3.380±1.093	4.620±1.836	-1.959	0.060
Weight (Kg)	17.450±4.381	19.650±5.726	-1.066	0.296
Height (cm)	105.250±9.007	102.575±14.908	0.519	0.608
BMI(Kg/m²)	15.636±2.288	19.796±9.893	-1.302	0.204
Chest circumference (cm)	54.600±3.534	56.875±4.872	-1.310	0.201

DISCUSSIONS

Adenotonsillar hypertrophies (ATH) is the most prevalent cause of chronic upper airway obstruction and sleep-disordered breathing [5, 7].

The daily clinical observation of weight-height growth delays in children with obstructive hypertrophy of the pharyngeal and palatine tonsils is a workaday practice in pediatric otorhinolaryngology and the surgical correction of this condition, when properly done in time, through adenotonsillectomy, can lead to a "catch up growth" [9, 16].

The current study was designed to assess the relationship between severity of chronic adenotonsillar hypertrophy and its impact on bone age and physical growth. It included 14 males (46.70%) and 16 females (53.3%), their mean age was 4.93 ± 1.36 years. There was obvious female predominance. This comes in contrast to previous studies [17-19] which reported predominance of males over females in suffering from chronic adenotonsillar hypertrophy. Ersoy *et al.* [20] reported a greater incidence among males with a ratio of 57: 43.

In the current study, children were clinically and radiologically graded according to Brodsky *et al.* scale [11]. Grade III was the most frequent among boys and girls on the grading of both tonsils and adenoid. This coincides with the data found by Bonuck *et al.* [15] who reported that (61%) of children presenting for tonsillectomy and adenoidectomy had grade III. While in Moghaddam *et al.* study [21], (85/5%) children were identified to have grade IV enlarged tonsil. On the other hand, in Toros *et al.* study [22], most of the children (54.7%) suffered from grade II tonsillar hypertrophy.

The patients' bone age was assessed by left hand x-rays and compared to Greulich and Pyle [23]. The results demonstrated that the bone age was delayed compared to chronological age with statistical significant difference ($p<0.05$) in the studied children. The delay was more evident in boys rather than in girls.

Table 5: Frequency (%) of children suffering from growth failure (≤ -2 SD)

	Total sample		Boys (N= 14)		Girls (N = 16)		Chi-square	
	N	%	N	%	N	%	X^2	P-value
WAZ (under weight)	5	16.67	2	14.29	3	18.75	0.027	0.870
HAZ (stunting)	10	33.33	3	21.43	7	43.75	0.820	0.365
BMI- Z score (under nourished)	2	6.67	2	14.29	0	0.00	0.533	0.4652

NB: WAZ: Weight for age Z score, HAZ: Height for age Z score

This was also noticed by Nieminen *et al.* [24], who found that children with OSAS and primary snorers had a retarded bone age with significant statistical difference (P <0.05), whereas the controls had an advanced bone age than their chronological age. Unfortunately, no researches conducted on the sex differences as regard the bone age assessment in ATH children, was reported.

The current study showed that the mean Z score for weight (-0.076 ± 1.49), height (-1.08 ± 2.17) and BMI (0.37 ± 2.10), which means that the mean Z scores of height revealed that the children was at risk of stunting, while weights and BMI of all patients under study were approximately equivalent to those of their healthy peers. These results were similar to those reported by Ersoy *et al.* [20] and Kang *et al.* [19] who found that the children's mean and Z score values for weight and BMI were within the normal values. However, they also reported that their height was within the normal values. *Kartal et al.* [16] observed that weight and height percentiles and SDS values were found to be normal in most of the patients. *Vontetsianos et al.* [25] in his study observed insignificant sex differences in the weight and height Z score of children with adenotonsillar hypertrophy.

On the other hand, Mozafarinia [26] found a decrease in the weight Z score for the case group compared to the control group with a statistical significant difference (P < 0.05) and most of the children in the case group were below third percentiles for height.

In our study, the mean value of the chest circumference for the total sample showed no abnormalities (56.12±4.54cm). According to the study conducted by Banzatto *et al*. [3], the mean thoracic circumference was 69.59cm before surgery. They also reported a mean increase of 2.1cm, (p <0.001) of the thoracic perimeter, six months after surgery.

Moreover; in the current study; the growth failure rate for weight was (16.67% of children = 5th percentile), height (33.33% of children = 5th percentile), both weight and height (10%= percentile) and BMI (6.67% of children = 5th percentile). In this study, stunting was detected in one third of the sample and underweight in about one fifth with statistically insignificant sex differences at the preoperative period. This coincides with *Velasco Suárez et al.* [8] who reported that ATH is associated with growth delay in children; mainly insufficient weight and height gain. Kartal *et al.* [16], study revealed that ATH can cause growth retardation by obstructing the upper airway. It has a negative effect on growth with a rate of up to 40%. The delayed growth in children with adenotonsillar hypertrophy may be related to the lower serum IGF-1 and plasma ghrelin. Since ghrelin increases hunger and food intake and its levels increase before the meals, lower levels lead to decreased appetite and also swallowing difficulties in children with adenotonsillar hypertrophy may lead to suboptimal nutrition [27]. However, It remains unknown whether growth failure is a result of hormonal changes caused by sleep-disordered breathing (SDB) or simply excessive energy expenditures to overcome the airway obstruction [28]. In children with adenotonsillar hypertrophy, daytime complaints including loss of appetite and leaving the table early are observed in addition to nighttime findings. As a result of difficulty in feeding caused by obstruction calorie intake decreases, the rate of increase in weight decreases in the short term, the rate of increase in height decreases in the long term and growth failure may develop. In addition, increased work load during respiration at night time in upper airway resistance syndrome in which respiratory effort is increased and hypoxia interrupts sleep at night decreases the quality and time of REM sleep by causing excessive energy loss and respiratory acidosis and decreased activity of growth hormone may result in growth failure in children [16].

Previous studies examined the incidence of growth failure in different locations. In Sweden Ahlqvist Rastad [29] found the incidence of underweight (Weight 2S.D.) <1% (1/22), while in Turkey Selimoglu [30]found it 10% (3/29). In Hong Kong Li [31] found the incidence of underweight (weight <3rd percentile) 5.7% (2/35). In USA Wong [32] found the incidence of underweight < 10th percentile 33%. In Turkey Yilmaz [33] found the incidence of stunted growth (height 3rd percentile) 3% (1/32) and Selimoglu [30] found it (Height 2S.D.)10% (3/29). In Hong Kong Li (2003) [31] found the incidence of stunted growth (height <3rd percentile) 5.7% (2/35). While, Bonuck *et al*. [15] found a growth failure rate of (14%) of children with height below the 5th percentile, (11%) of children with weight below the 5th percentile and (7%) children having height and /or weight below the 5th percentile.

CONCLUSION

Adenotonsillar hypertrophy (ATH) had insignificant effect on the anthropometric measurements of young children. However, it causes significant delayed bone age mainly in males and stunting with insignificant sex differences.

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