EFFECT OF ADENOTONSILLECTOMY ON THE RIGHT VENTRICULAR DIASTOLIC FUNCTIONS IN CHILDREN WITH ADENOTONSILLAR HYPERTROPHY

Original Research

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ADENOONSİLEKTOMİ'NİN ADENOİD'Lİ ÇOCUKLARDA SAĞ VENTRİKÜLER DİASTOLİK FONKSİYONLARA ETKİSİ

ADENOTONSILLECTOMY EFFECT ON DIASTOLIC FUNCTIONS

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Öz

Bu çalışmada obstrüktif adenotonsiller hipertrofi olan çocuklarda sağ ventrikül fonksiyonlarının araştırılması amaçlanmıştır. Bu amaçla, sağ ventrikül diyastolik fonksiyonları adenotonsillektomi öncesi ekokardiyografi ile ve en erken ameliyattan 6 ay sonra değerlendirilmiştir. Kliniğimize horlama, ağız solunumu ve / veya apne şikayetleri ile başvuran adenotonsiller hipertrofi olan çocuklar dahil edildi. Ameliyat öncesi tam bir kan sayımı, rutin biyokimyasal kan tetkikleri, göğüs radyografisi, elektrokardiyografi ve doku Doppler ekokardiyografi yapıldı. Elektrokardiyografi ve doku Doppler ekokardiyografi, en erken 6 aylık adenotonsillektomi sonrası hastaların takip ziyaretleri sırasında tekrarlandı. Postoperatif 6. ayda değerlendirmede, hastaların hiçbirinde horlama veya apne görülmedi. Ameliyat sonrası bazı ekokardiyografik parametrelerde önemli değişiklikler saptanmasına rağmen sağ ventrikül morfolojik anormallikleri saptanmadı. Sol ventrikül boyutlarının ekokardiyografik ölçümleri normal sınırlardaydı. Bununla birlikte, triküspid kapağın pik erken ve geç doku hareket hızına doku Doppler görüntüleme oranı post-operatif dönemde preoperatif perioddan daha yüksekti. Bu, diyastolik fonksiyonların görece li olarak düzelmesinden kaynaklanabilir.

Anahtar Kelimeler

Adenotonsiller Hipertrofi; Obstrüktif Uyku Apnesi; Kardiyak Disfonksiyon; Adenotonsillektomi

Abstract

The present study aimed to investigate the right ventricular function in children with obstructive adenotonsillar hypertrophy. For this purpose, right ventricular diastolic functions were evaluated via echocardiography before adenotonsillectomy and after a minimum of 6 months following surgery. Children with adenotonsillar hypertrophy who were admitted to our clinic with the complaints of snoring, mouth breathing, and/or witnessed apnea were included. Pre-operatively, a complete blood cell count, routine biochemical blood tests, chest radiography, electrocardiography, and tissue Doppler echocardiography were performed. Electrocardiography and tissue Doppler echocardiography were repeated on the follow-up visits of the patients after a minimum of 6 months following adenotonsillectomy. Evaluation of the patients in the post-operative 6th month revealed no snoring or apnea in any of the patients. Although significant changes were detected in certain echocardiographic parameters after the surgery, right ventricular morphological abnormalities were not detected. Also, echocardiographic measurements of left ventricular dimensions were within the normal limits. Nevertheless, the ratio of peak early to late tissue motion velocity of the tricuspid valve as determined by tissue Doppler imaging was higher in the post-operative period than in the pre-operative period. This might be attributed to the relative improvement in diastolic functions.

Keywords

Adenotonsillar Hypertrophy; Obstructive Sleep Apnea; Cardiac Dysfunction; Adenotonsillectomy

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Introduction

Adenotonsillar hypertrophy is the most common cause of obstructive sleep apnea syndrome in children [1] It is known that several cardiovascular complications such as right and left ventricular dysfunction, pulmonary hypertension, heart rate variability, and heart failure can develop as the result of hypercarbia and hypoxemia, which occur in such children due to mechanical airway obstruction [2-8]. Adenotonsillectomy is the first treatment of choice in obstructive sleep apnea syndrome and early surgery prevents and/or reverses many complications [9,10]. The presence of cardiac involvement is also a risk factor for complications that are likely to occur following adenotonsillectomy [11]. For these reasons, detection of subclinical cardiac dysfunctions, in particular, is of great importance. Although there are invasive and noninvasive parameters for the assessment of ventricular function, it remains difficult and challenging to quantify right ventricular function. Quantification of myocardial function has become available with the introduction of tissue Doppler echocardiography [12].

Patients with severe upper airway obstruction can experience cor pulmonale later in life; however, there is little information about right ventricular function early in the disease. Therefore, the present study aimed to investigate the right ventricular function in children with obstructive adenotonsillar hypertrophy as detected by tissue Doppler echocardiography. For this purpose, right ventricular diastolic functions were evaluated via echocardiography before adenotonsillectomy and after a minimum of 6 months following surgery.

Material and Method

Children with adenotonsillar hypertrophy who were admitted to our clinic with the complaints of snoring, mouth breathing, and/or witnessed apnea for more than 8 months were included in the study. Patients having heart or renal failure or severe lung disease and those having upper airway obstruction due to other reasons, such as presence of nasal polyps, in their history, physical examination, or laboratory data were excluded. Data regarding history of snoring and apnea symptoms of the patients were obtained from their parents. Measurements of arterial oxygen saturation were performed using an oximetry monitor (Hewlett Packard M3046A, Viridia M3, Germany), which simultaneously measures oxyhemoglobin concentration, cardiac rhythm, and breath rate. A complete blood cell count, routine biochemical blood tests, chest radiography, electrocardiography, and tissue Doppler echocardiography were performed preoperatively. A complete ear, nose, and throat examination was also performed, which was supported by nasal and nasopharyngeal endoscopy as appropriate for additional assessment of the nasal patency and adenoid size. The nasopharyngeal air column was imaged using lateral skull radiography in all patients. Adenotonsillectomy was performed by curettage and cold dissection methods under general anesthesia. Electrocardiography and tissue Doppler echocardiography were repeated on the follow-up visits of the patients after a minimum of 6 months following surgery.

Upper airway obstruction was pre-operatively graded as follows: Grade I, tonsils being in the tonsillar fossa, barely visible behind the anterior pillars; Grade II, tonsils being easily visible behind the anterior pillars; Grade III, tonsils extending three-quarters of the way to the midline; and Grade IV, tonsils completely obstructing the airway [13]. Adenoid hypertrophy was graded according to the severity of the airway obstruction: mild (1°) indicates <25% obstruction; moderate (2°) indicates 25%-50% obstruction; moderately severe (3°) indicates 50%-75% obstruction; and severe (4°) indicates >75% obstruction [14].

Snoring was classified as follows: mild, with snoring being present only in the supine position and not being present every night; moderate, with snoring being present every night and diminishing with positional changes; and severe, with snoring being present every night and not changing with the position [15]. M-mode echocardiography, two-dimensional echocardiography, pulsed and continuous wave Doppler studies, and tissue Doppler imaging were performed using an echocardiography unit (Vingmed System Five Performance, General Electric Co., Cincinnati, OH, USA) with a 5 MHz duplex imaging transducer. The echocardiographic measurements were performed by an experienced cardiologist who was blinded to the diagnosis of the patients. Parameters were averaged over 3 cardiac cycles and all measurements were performed according to the guidelines of the American Society of Echocardiography [16]. Left ventricular fractional shortening and ejection fraction were calculated by M-mode echocardiography according to the Teichholz method [17]. The pulsed Doppler method was used to measure blood flow through cardiac valves (mitral, tricuspid); flow velocity during early filling; flow velocity during atrial contraction; and isovolumic relaxation time. Then the ratio of early to late ventricular filling velocities was calculated. Measurements obtained from pulsed tissue velocity imaging were systolic right ventricular free wall, early and late diastolic myocardial velocities, and their ratios.

The present study was approved by the Ethics Committee of Atatürk University and informed consents of the patients were obtained from their parents or legal representatives.

Statistical Analysis

Data were analyzed using the Predictive Analytics Software (SPSS Inc., Chicago, IL, USA) version 18.0 for Windows program. Descriptive statistics were expressed as number and percentage for categorical variables and as mean, standard deviation, median, minimum, and maximum for numerical variables. The Wilcoxon signed-rank test was used to determine the change in time for non-normally distributed variables. A p value of <0.05 was considered statistically significant.

Results

The present study included 25 patients with a mean age of 8.5±2.9 years, of whom 8 were female (mean age 9.4±2.7 years) and 17 were male (mean age of 8.2±3.0 years). Characteristics of the patients with adenotonsillar hypertrophy are shown in Table 1.

Chest radiography revealed cardiomegaly in 2 patients with a moderate degree of apnea. Electrocardiographic abnormalities were as follows: right axis deviation in 2 (8%) patients, right ventricular hypertrophy in 1 (4%), and right atrial hypertrophy in 1 (4%) (these 4 patients had moderate apnea), and left axis deviation in 1 (4%) patient, sinus tachycardia in 3 (12%), and

Table 1. Characteristics of children with adenotonsillar hypertrophy

Characteristics	
Gender	
Girl	8 (32.0)
Boy	17 (68.0)
Age, year	8.0 (2.5-13.0)
Tonsil size	
Grade I	3 (12.0)
Grade II	10 (40.0)
Grade III	11 (44.0)
Grade IV	1 (4.0)
Adenoid size	
1°	0 (0.0)
2°	9 (36.0)
3°	7 (28.0)
4°	9 (36.0)
Snoring	
None	1 (4.0)
Mild	2 (8.0)
Moderate	11 (44.0)
Severe	11 (44.0)
Witnessed apnea	16 (64)
Arterial oxygen saturation, %	97 (95-99)
Respiratory rate, breath/min	25 (18-32)
Pulse rate, beat/min	98 (84-154)
Systolic blood pressure, mmHg	90 (80-100)
Diastolic blood pressure, mmHg	60 (50-60)

Values are presented as number (%) or median (minimum-maximum), where appropriate.

Mobitz type 1 second-degree atrioventricular block in 1 (4%). Sixteen (64%) patients did not have any electrocardiographic abnormalities. In the post-operative period, it was observed that sinus tachycardia in 2 patients, right axis deviation in 1 patient, and Mobitz type 1 second-degree atrioventricular block in 1 patient were improved.

The echocardiographic results of pre- and post-operative periods are presented in Table 2. The increase in the left ventricular end-diastolic dimension and the increase in the left atrium values were significant in the post-operative period as compared to the pre-operative period. In addition to the significant increase in the left ventricular inflow deceleration time in the post-operative period, significant increases in the right ventricular inflow acceleration and deceleration times were also detected. There was also a significant increase in the peak early to late diastolic tissue motion velocity of the tricuspid valve in the post-operative period.

Evaluation of the patients in the post-operative 6th month revealed that none of the patients had snoring or apnea.

Table 2. Comparison of echocardiographic results of the patients between pre- and post-operative periods

	n	Pre-operative Period Median (Min-Max) (Mean)	Post-operative Period Median (Min-Max) (Mean)	p
LVEDD (mm)	25	32.20 (22.70-43.10) (34.26)	37.10 (26.00-42.60) (36.33)	0.007
IVS (mm)	25	6.80 (4.50-9.00) (6.70)	6.60 (4.80-9.40) (6.77)	0.932
LA (mm)	25	23.20 (16.60-29.10) (22.86)	24.90 (16.60-30.30) (24.74)	0.011
EF (%)	25	76.00 (63.00-87.00) (74.84)	74.00 (64.00-87.00) (74.32)	0.875
LV inflow				
AT (ms)	24	66.67 (32.79-85.25) (64.59)	63.94 (39.34-98.36) (66.74)	1.000
DT (ms)	24	119.49 (76.08-183.45) (121.04)	133.52 (80.99-280.63) (145.39)	0.009
E (ms)	24	1.01 (0.74-1.26) (0.99)	1.02 (0.67-1.46) (1.04)	0.095
A (ms)	24	0.64 (0.51-0.80) (0.63)	0.62 (0.38-0.86) (0.62)	0.886
E/A	24	1.54 (1.38-2.00) (1.60)	1.66 (1.31-2.22) (1.71)	0.086
RV inflow				
IVRT (ms)	24	69.10 (44.77-118.23) (67.52)	63.51 (46.72-91.97) (62.71)	0.218
AT (ms)	25	68.85 (35.04-101.63) (72.06)	87.41 (59.02-122.95) (85.01)	0.011
DT (ms)	25	107.51 (59.34-166.35) (111.47)	144.00 (83.74-210.87) (147.99)	0.001
E (ms)	25	0.78 (0.54-1.09) (0.80)	0.78 (0.45-1.07) (0.78)	0.798
A (ms)	25	0.6 (0.41-0.81) (0.60)	0.56 (0.31-0.91) (0.57)	0.217
E/A	25	1.33 (0.85-2.14) (1.36)	1.40 (0.98-2.04) (1.40)	0.339
TV annular TDIe (ms)	25	0.14 (0.11-0.26)(0.15)	0.15 (0.10-0.19) (0.15)	0.124
a (ms)	25	0.10 (0.08-0.20) (0.12)	0.11 (0.06-0.16) (0.11)	0.527
e/a	24	1.30 (0.77-1.86) (1.26)	1.30 (0.99-2.14) (1.42)	0.041

LVEDD, left ventricular end-diastolic dimension; IVS, interventricular septum; LA, left atrium; EF, ejection fraction; AT, acceleration time; DT, deceleration time; E, peak velocity of early diastolic filling; A, late diastolic filling due to the atrial contraction; E/A, ratio of early to late ventricular filling velocities; RV, right ventricle; IVRT, isovolumic relaxation time; TV, tricuspid valve; TDI, tissue Doppler imaging; e: peak early diastolic tissue motion velocity , a: peak late diastolic tissue motion velocity, e/a: peak early to late diastolic tissue motion velocity.

Discussion

Studies have demonstrated that subclinical cardiac dysfunctions can be detected via echocardiography in children with obstructive sleep apnea syndrome due to adenotonsillar hypertrophy and that these abnormalities are reversible with the treatment of obstructive sleep apnea syndrome [18-22]. In their study on 42 children with obstructive sleep apnea syndrome due to adenotonsillar hypertrophy and 45 healthy children, Attia et al. [18] assessed the right and left myocardial performance indexes by tissue Doppler echocardiography before and after adenotonsillectomy. They demonstrated impairment in the left and right ventricular functions in the patient group and they reported that subclinical changes in cardiac performance improved after the surgery and that the post-operative echocardiographic parameters did not differ between the patients and the controls. Chan et al. [19] selected 101 children from a community based questionnaire survey, grouped them according to the degree of obstructive sleep apnea using polysomnography, and evaluated cardiac functions by echocardiography. They reported that right ventricular systolic volume index was greater, right ventricular ejection fraction was lower, right ventricular myocardial performance index was higher, and the risk of abnormal left ventricular geometry was higher in the moderate to severe obstructive sleep apnea group than in the reference group. Moreover, an improvement in cardiac functions was reported after 6 months of treatment (adenotonsillectomy or nasal steroids). In their study of children with adenotonsillar hypertrophy (n=30) and healthy children (n=30), Cincin et al. [20] demonstrated high pulmonary artery pressure and impaired right ventricular functions in the patients having obstructive sleep apnea symptoms due to adenotonsillar hypertrophy. In addition, they reported improvement in the right and left ventricular myocardial performance indexes after adenotonsillectomy. Goldbart et al. [21] performed a study on children with obstructive sleep apnea (n=90) and healthy children (n=45) and demonstrated that tricuspid regurgitation abnormality and increased pulmonary pressure detected by Doppler in 40 children with obstructive sleep apnea were decreased after adenotonsillectomy. Miman et al. [22] measured pulmonary pressure by Doppler echocardiography in 17 children with pulmonary hypertension secondary to adenotonsillar hypertrophy and demonstrated that pulmonary pressure dramatically decreased to normal levels following adenotonsillectomy. In the study by Lee et al. [23], children (n=21) with adenotonsillar hypertrophy and healthy age- and gender-matched controls (n=21) were compared. Through questionnaires administered to the families, they determined that all the children with adenotonsillar hypertrophy, except for one, snored loudly and experienced sleep apnea. They also reported that there was no significant difference between the children with adenotonsillar hypertrophy and controls in terms of echocardiographic parameters.

In the present study, although significant changes were detected in certain echocardiographic parameters after the surgery, as could be expected due to the mild degrees of sleep-related breathing disorders and the lack of associated obstructive lung disease, right ventricular morphological abnormalities were not detected. Also, echocardiographic measurements of left ventricular dimensions were within the normal limits [24]. Nevertheless, the ratio of peak early to late tissue motion velocity of tricuspid valve determined by tissue Doppler imaging was higher in the post-operative period than in the pre-operative period. This might be attributed to the relative improvement in diastolic functions.

Competing interests

The authors declare that they have no competing interests.

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