LEFT ATRIAL DIAMETERS IN OVERWEIGHT CHILDREN WITH NORMAL BLOOD PRESSURE

Jeong Jin Yu, MD, Hee Hyun Yeom, MD, Sochung Chung, MD, Youngshin Park, MD, and Dong Hwan Lee, MD

Objective To measure left atrial (LA) diameter in normotensive, overweight children and to determine the variables that independently influence LA diameters.

Study design A cross-sectional study on 22 overweight children (age, 13.40 ± 1.22 years) and 18 control children (age, 13.40 ± 2.19 years) was performed. LA diameter, left ventricular (LV) geometry, and LV systolic/diastolic function were measured through echocardiography. Data were compared between the two groups. Multiple regression analysis, with LA diameter as dependent variable, was conducted.

Results In the overweight group, LV diastolic dimension, LV mass index, peak S, S/D ratio, Am, maximal LA diameter (34.1 mm vs 25.4 mm), middle LA diameter (26.9 mm vs 18.1 mm), and minimal LA diameter (22.5 mm vs 16.1 mm) were increased and Em/Am ratio was decreased. In multiple regression analysis, body mass index (R^2 = 0.7040, 0.7085, 0.7406 in respective maximal, middle, and minimal LA diameter) and systolic blood pressure (R^2 = 0.0540, 0.0477, 0.030 in respective maximal, middle, and minimal LA diameter) were significant independent correlates of all three measures of LA diameter.

Conclusions LA diameter in normotensive overweight children is increased. Body mass index and systolic blood pressure were significant correlates of LA diameter. *(J Pediatr 2006;148:321-5)*

In uncomplicated overweight adult patients without cardiac disease or hypertension, the increase in left atrial (LA) size has been observed.[1,2] However, there have been few studies that have evaluated LA size in overweight children. Increased preload may appear in the initial period of obesity.[3] Therefore we speculated that LA enlargement caused by the increase of preload might be detected in overweight children. In the study reported by Daniels et al[4] in children with hypertension, body mass index (BMI) was a significant independent correlate of LA size. This implies the possibility of LA enlargement in normotensive overweight children.

In the Framingham study, Benjamin et al[5] found that LA enlargement was associated with an increased risk of stroke in men and death in both sexes after multivariable adjustment. This implies that LA enlargement may be an independent risk factor for future cardiovascular diseases. Therefore, in the evaluation of overweight children as a group at risk of future cardiovascular diseases,[6,7] Measurement of LA diameter could be useful.

The purpose of this study was to measure LA diameter, left ventricular (LV) geometry, and systolic/diastolic function of the LV in normotensive overweight children, to compare the measurements with data from normal-weight children, and to find out which variables independently influence LA diameter.

METHODS

Subjects

The children who volunteered for the study were all over 10 years old. They either had participated in the Obesity Camp for Adolescents in 2004 offered by the Department of Pediatrics, Soonchunhyang University Hospital, or were friends of the camp participants or children of the hospital staff. Written informed consent was obtained from the parents or guardians of all children. Any systemic disease or medication history was ruled

Am	Peak diastolic tissue velocity during atrial contraction	LADmin	Minimal LA diameter
BMI	Body mass index	LV	Left ventricle
Em	Peak early diastolic tissue velocity	LVDd	Diastolic left ventricular dimension
HR	Heart rate	LVDs	Systolic left ventricular dimension
LA	Left atrium	LVMI	Left ventricular mass index
LADmax	Maximal left atrial diameter	RWT	Relative wall thickness
LADmid	Middle left atrial diameter	SBP	Systolic blood pressure
		SV	Stroke volume

From the Department of Pediatrics, Konkuk University School of Medicine, Soonchunhyang University College of Medicine, Seoul, Korea.

Submitted for publication Jul 13, 2005; last revision received Sep 27, 2005; accepted Oct 20, 2005.

Reprint requests: Dr Jeong Jin Yu, Department of Pediatrics, Konkuk University Hospital, 1, Hwayang-dong ,Gwangjin-gu, Seoul, 143–914, Korea (South). E-mail: pediatrist@medimail.co.kr.

0022-3476/$ - see front matter

10.1016/j.jpeds.2005.10.042

out by history and physical examination. After the children rested 10 minutes in the supine position, blood pressure was measured with the use of a sphygmomanometer. In camp participants, blood pressure was measured 2 times or more at intervals of more than 1 week. In other participants, blood pressure was measured once. On the basis of normal blood pressure values,[8] children showing systolic or diastolic blood pressure over the 95th percentile were excluded from the study population. Heart rate (HR) was the average of 3 measurements; immediately before, in the middle of, and after the completion of echocardiography. After measuring the weight and height, BMI (kg/m^2) was calculated, and its percentile was obtained, based on standards for Korean children.[9] Finally, the overweight group consisted of 16 children with BMI > 95th percentile and 6 children with BMI in the 85th ~ 95th percentile. The normal-weight comparison group consisted of 18 children with BMI < 85th percentile.

Echocardiographic Examination

All echocardiographic studies were performed by one echocardiographer, blinded to the subject's status. The equipment used was the Hewlett-Packard Sonos 5500 with a 3-MHz transducer attached. Three still images at the end-expiratory phase were stored in magneto-optical discs in each echocardiographic test. The actual measurements were performed offline by another person, and the data were analyzed as the average of measurements from the 3 images.

Diastolic LV dimension (LVDd) and systolic LV dimension (LVDs) was measured through 2-dimensional targeted M-mode echocardiography. The stroke volume (SV) of the left ventricle was obtained by the calculation according to the formula suggested by Teichholz et al[10]: $SV = 7 \cdot [LVDd^3/(2.4 + LVDd) - LVDs^3/(2.4 + LVDs)]$. LV mass was calculated by the formula described by Devereux and Reichek.[11] LV mass index (LVMI) was obtained by dividing LV mass by $height^{2.7}$. The percentile of LVMI was obtained, based on normal value.[12] Relative wall thickness (RWT) was calculated as (diastolic interventricular septal thickness + diastolic LV posterior wall thickness)/LVDd. Cutoff levels for LVMI (>97.5th percentile) and RWT (>0.41) were used to evaluate LV geometry. This results in 4 categories of LV geometry: normal, concentric remodeling, eccentric hypertrophy, and concentric hypertrophy.[4]

Mitral valve inflow Doppler tests and pulmonary venous flow Doppler tests were performed according to the guideline standardized by Appleton et al.[13] On apical 4-chamber view, in the interventricular septum basal portion, under the optimal low filter/gain setting, the peak early diastolic tissue velocity (Em) and the peak diastolic tissue velocity during atrial contraction (Am) were measured.

Three LA diameters were measured according to the method used by Briguori et al.[14] They were the maximal LA diameter at the end-systolic period (LADmax), the middle LA diameter immediately before the contraction of the atrium (LADmid), and the minimal LA diameter at the completion of the contraction of the atrium (LADmin). To evaluate the variability of LA diameters measured, we also calculated the percent precision.[15] Twenty M-mode images of the LA were randomly selected, and three LA diameters for each image were determined by one observer on two occasions (intraobserver variability) and by two observers on two occasions (interobserver variability).

Table I. Comparison of clinical characteristics between obese children and nonobese children

	Obese children (n = 22)	Nonobese children (n = 18)	*P* value
Sex (M/F)	16/6	11/7	.5090
Age (y)	13.40 ± 1.22	13.40 ± 2.19	.9545
Height (cm)	154.6 ± 8.1	159.1 ± 12.7	.1995
Weight (kg)	68.4 ± 14.2	46.0 ± 12.2	<.0001
Body mass index (kg/m^2)	28.4 ± 3.6	17.9 ± 2.5	<.0001
Systolic BP (mm Hg)	117.1 ± 8.5	113.7 ± 8.8	.2641
Diastolic BP (mm Hg)	69.0 ± 5.7	69.0 ± 8.4	.9879
Heart rate (bpm)	74.3 ± 10.1	79.4 ± 10.8	.1293

Data are mean ± SD.
BP, blood pressure; *bpm*, beats per minute.

Statistical Analysis

Data are given as mean ± SD. All statistical analysis were performed with the use of SAS 6.12, and statistical significance was assessed by using an α level of .05. The Fisher exact test was conducted to examine whether sex distribution was different between groups. The unpaired Student *t* test was used to compare numeric variables between groups. Correlations between numeric variables were determined by Pearson correlation analysis. To find out which variables describe measured LA diameters, stepwise multiple linear regression analysis (SLS 0.15, SLE 0.15) was conducted.

RESULTS

Clinical characteristics were not different, other than the weight and BMI, between the overweight group and the normal-weight group (Table I). The results of echocardiographic measurement are shown in Table II. LV geometry and systolic function, LVDd, diastolic interventricular septal thickness, and LVMI were significantly increased in the overweight group. In total, there were 5 cases of eccentric hypertrophy, 1 case of concentric hypertrophy, and 3 cases of concentric remodeling. Among the 3 cases of concentric remodeling, 1 case belonged to the normal-weight group. In LV diastolic function tests, the peak S, the peak S/D ratio, and Am were elevated, and the Em/Am ratio was reduced in the overweight group. All three measures of LA diameter were increased significantly in the overweight group. The intraobserver percent precisions of LADmax, LADmid, and LADmin were 2.5%, 3.1%, and 7.0%, respectively, and the interobserver percent precisions were 3.7%, 5.2%, and 3.4%, respectively.