

The Significance of B-Mode Echocardiography, Twenty-Four-Hour Ambulatory Blood Pressure Monitoring with Shiller Blood Pressure Monitor and Electrocardiography for Diagnosis and Treatment of Essential Arterial Hypertension in Children

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Introduction. Essential, primary, or idiopathic hypertension is defined as high blood pressure in which secondary causes such as renovascular disease, renal failure, pheochromocytoma, aldosteronism, or other causes of secondary hypertension or mendelian forms (monogenic) are not present. This pathology causes damages of organ target (TOD) (usually the cardiovascular system, kidneys and eyes) which may lead to a significant worsening of the quality of life. Therefore an early diagnostic and an appropriate treatment is so important for example the most important examination for assessing the changes of morphology structure of myocardium is echocardiography. An early and accurate diagnostic of TOD allows avoiding or reducing their complications.

The aim of this work is to determine the significance of various instrumental methods of examination (echocardiography (ECHO), twenty-four-hour ambulatory blood pressure monitoring (24-h ABPM) with Shiller blood pressure monitor and electrocardiography (ECG)) for the diagnosis and treatment of the essential arterial hypertension (EAH) in children.

The objectives.

1. To assess data of B-ModeECHO and how their related with sex, symptoms, TOD and consumption of medications.
2. To compare data (symptoms, TOD) of children who had confirmed diagnosis of EAH by 24-h ABPM and general medical doctor and to assess importance of examinations for diagnostic and treatment of children's EAH.
3. To determine connection between the gravity of arterial hypertension (AH) (assessing 24-h ABPM) with symptoms and TOD.

Methods. The study involved the data of patients 14-18 years old who were hospitalized in the Lithuanian University of Health Sciences to a Pediatrics Clinic in the II pediatrics department 2013-2015 years with confirmed EAH by general medical doctor. The population of the study was 156 children with confirmed EAH. There were 117 (75%) boys and 39 (25%) girls in this study. The mean age of the boys were 15.86 (SD= 1.213) and of the girls 15.44 (SD= 0.912) ($p = 0.138$). AH can be confirmed in two different

ways: systolic and/or diastolic office blood pressure (BP) is determined $> 95^{\text{th}}$ percentile according to the graph of children's height and age percentile during the three different measurements; [3][6] and during 24-h ABPM with Shiller BP monitor, when the mean systolic or diastolic BP $> 95^{\text{th}}$ percentile, and systolic or diastolic BP load $\geq 25\%$ also the severe AH is diagnosed when the mean systolic or diastolic BP $> 95^{\text{th}}$ percentile, and systolic or diastolic BP load $> 50\%$. [2] The operating principle of 24-h ABPM: BP monitoring should be taken every 15–20 min during the daytime and every 20–30 min at night to avoid interfering with activity or sleep. However, measurements can be made more frequently. To be considered successful, at least 85% of readings should be suitable for analysis. 24-h ABPM profiles should be interpreted with reference to activity and sleep patterns. Ambulatory BP monitoring may not be accurate during exercises, movements or when the patient has the irregular rhythm of cardiac. These factors can cause errors, but this monitor is enough reliable and approved for using of diagnostic of hypertension. This diagnostic method is safe and usually is not associated with complications. However, occasionally it can be petechiae of the upper arm or bruising under the inflating cuff. Also it can cause sleep disturbances. [1]. The study objectives were sex, age, BP, heart rate, 24-h ABPM with Shiller BP monitor (systolic $> 95\%$, systolic $> 99\%_{\text{0}+5}$, diastolic $> 95\%$, diastolic $> 99\%_{\text{0}+5}$), symptoms (headache, dizziness, weakness/fatigue, nausea, syncope, heart palpitations, pressure/stabbing chest, dyspnea, exercise's intolerance), TOD (proteinuria (serum proteins in the urine $> 0.1\text{g/l}$)), retinopathia, left ventricular hypertrophy (LVH), risk factors (family medical history, smoking, diabetes mellitus), consumption of medications (AKFI, BAB, KKB, ARB, A II blockers), data of B Mode ECHO (left ventricular diastolic diameter (LVDD), right ventricular (RV), left atrial (LA), right atrial (RA), ejection fraction (EF) diameter), data of ECG. There were evaluated results of LVDD, RV, LA, RA, EF diameter during ECHO, results of 24-h ABPM also pathologic changes of ECG and searched connection between gender, age, risk factors, TOD, consumption of medications and symptoms. Pathologic LVDD was defined as $> 5.3\text{ cm}$, LA – diameter $> 3.9\text{cm}$, RA $\rightarrow 4.5\text{cm}$, RV $\rightarrow 3.3\text{cm}$, EF $< 55\%$. [4] ECHO carried on VIVID S6 high-performance imaging B-Mode 3 MHz cardiovascular ultrasound system. BFI (Blood Flow Imaging) displays colour Doppler with speckle reflectors for better flow visualization of hemodynamic patterns. Full cardiac, vascular, and OB/GYN reporting. Semi-automatically and method was used to measurement of parameters of heart morphological and function. Accuracy of results can cause experience of examiner. SHILLER AT-101 electrocardiograph was using for ECG registration. 12 standards leads were registered for all of children (used 25 mm/s speed and 10 mm match 1 mV). Ethics Committee Bioethics edition number BEC-MF-61. Statistical analysis was performed using SPSS 23.0 and Microsoft Excel 2016 software. The nominal data were analyzed by using the 95 % confidence interval for population proportion and Chi square test for independence (or homogeneity).

Results of analysis are presented as frequency and relative frequency (%) of analyzed values. Quantitative data were analyzed using the Student's t test for independent population. Results of the analysis are presented as mean and standard deviation (SD). A p-value < 0.05 was considered statistically significant.

Results. According to the standard of Lithuanian University of Health Sciences of Pediatrics Clinic pediatric's cardiologists general agreement 14,1% of patients have increased LVDD (95 % CI 8.64 – 22.74), RV 8.3 % (95 % CI 3.97% – 12.27%), LA 17.9 % (95 % CI 11.88 – 29.78) but RA and EF was found normal. According to the results of study there was significant difference between the sexes. The boys with confirmed EAH have statistically significantly more often increased LVDD (21 (13.5 %) vs 1 (0.6 %), p=0.017), LA (28 (17.9 %) vs 1 (2.6 %), p = 0.003) and the changes of ECG (34 (29.1 %) vs 4 (10.3 %), p = 0.018) than the girls who have the same diagnosis. Others pathological changes of ECHO did not have statistically significantly difference between the sexes. Significant correlation did not observe between heart's morphology changes (determined during ECHO) and symptoms, TOD or consumption of medications. AH was diagnosed to 69.2 % patients (95 % CI 61.96 – 76.45) and was not determined 30.8 % (95 % CI 23.56 – 38.05) during 24-h ABPM. Ambulatory hypertension was diagnosed to 35.5 % (95 % CI 27.80 – 42.8) and severe ambulatory hypertension - 34 % (95 % CI 26.57 – 41.44) between the patients who had diagnosis of AH by 24-h ABPM. The children who were determined EAH by 24-h ABPM statistically significantly less complained about a headache compared with the children who were diagnosed EAH by general medical doctor (48 (44.4%) vs 30 (62.5 %) p=0.037). However, others symptoms and TOD had not statistically significantly difference between these patients who had the different way of diagnostic EAH. It was 50.9 % (95 % CI 41.47 – 60.33) of ambulatory hypertension and 59.1 % (95 % CI 39.67 – 58.53) of severe ambulatory hypertension between the patients with confirmed AH diagnosis during 24-h ABPM. The clinical manifestations differed between the children who had diagnosis of severe ambulatory hypertension and ambulatory hypertension during 24-h ABPM (see Tab. 1). Symptoms and others TOD had not statistically significantly difference between these group patients.

Table 1. Ambulatory and severe essential arterial hypertension by Shiller and clinical changes

Changes	Ambulatory EAH n = 55 (50.9 %)	Severe EAH n= 53 (49.1 %)	P value
ECG changes	10 (18.2 %)	19 (35.8 %)	0.038*
LA changes	16 (30.2 %)	5 (9.1 %)	0.006*
LVDD changes	5 (9.1 %)	9 (17 %)	0.222
RA changes	6 (10.9 %)	2 (3.8 %)	0.157

Symptoms	42 (76.4 %)	34 (64.2 %)	0.165
Proteinuria	20 (36.4 %)	16 (30.2 %)	0.496
Adipositas	6 (10.9 %)	5 (9.4 %)	0.800
Family medical history	20 (36.4 %)	16 (30.2 %)	0.496

*Significant at $P < 0.05$. ECG – electrocardiography, LA- essential arterial hypertension, LVDD - left ventricular diastolic diameter, RA- right atrial, EAH - essential arterial hypertension.

Conclusions:

1. Morphologic changes of heart (LVDD and LA diameter) determined during ECHO and caused by EAH manifested statistically significantly more often to the boys but they were not related with symptoms, others TOD and consumption of medication.

2. The AH's diagnosis by general medical doctor and 24-h ABPM are equally important to diagnose the EAH because the frequency of the clinical manifestations did not differ.

3. 24-h ABPM is important to evaluate the gravity of EAH because severe ambulatory hypertension is related with more often manifestation of ECG's and LA diameter changes compared with ambulatory hypertension determined during 24-h ABPM.

In conclusion for diagnostic and choosing plan of treatment to the EAH is enough to choose one of the diagnostic methods - 24-h ABPM or general medical doctor. 24-h ABPM is very important to determine the gravity of EAH because patients with diagnosis of severe ambulatory hypertension usually have more often target organ – heart – damages. Therefore, it is important to follow carefully ECG and LA diameter to the children who have diagnosis of severe ambulatory hypertension because those changes manifested more often to them. Moreover, B-Mode ECHO have to be evaluated more often to the boys with confirmed EAH because changes of LVDD and LA diameter manifested more often to the male's sex. According to this latest study's result, there is important to do research for found out which causes of EAH can be determinate different influence to the heart's structure for different sex.

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AH has become an increasingly important medical problem in children and adolescents. Outcomes related to childhood AH include LVH, retinopathy, nephropathy, psychosocial problems also childhood AH can lead to adult hypertension. This study objectives were assess data of B-Mode ECHO and ECG and how their related with sex, symptoms, TOD and consumption of medications and importance of two different examinations for diagnostic and treatment of children's EAH also to determine connection between the gravity of AH (assessing 24-h ABPM) with symptoms and TOD. The study involved the data of patients 14-18 years old who were hospitalized with confirmed EAH by general medical doctor. The results showed that the boys are the biggest part of children who have diagnosis of AH. Moreover, the boys with confirmed EAH had more often increased LVDD and the changes of ECG. In addition pathologic ECG's and increased LV were more often to children who had the severe ambulatory hypertension comparing with the children who had the ambulatory hypertension during 24-h ABPM. So the AH's diagnosis by general medical doctor and 24-h ABPM are equally important to diagnose the EAH because the frequency of the clinical manifestations did not differ but 24-h ABPM is important to evaluate the gravity of EAH.