



# DIAGNOSTIC VALUE OF CARDIAC ULTRASOUND IN ESTIMATING THE DURATION OF ARTERIAL HYPERTENSION

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**SUMMARY** – The aim of the study was to assess the correlation between the degree and duration of arterial hypertension and the hypertrophy of the left ventricle and the ejection fraction of the heart, with cardiac ultrasound. Our prospective study included 50 patients with arterial hypertension as leading diagnosis. All 50 patients were consecutively examined in the Emergency Department and then referred to the Cardiac clinic of the Clinical Hospital “Sveti Duh” for further evaluation. The inclusion criteria were male and female aged 18 and older and arterial hypertension as leading diagnosis during Emergency Department visit. Exclusion criteria were pathological conditions that alter myocardial architecture and impair contractility. Measurement of the left ventricle thickness based on the thickness of the intraventricular septum and the posterior wall of the left ventricle, and the ejection fraction was ultrasonically determined. The highest proportion of subjects was with the first degree of arterial hypertension, followed by subjects with a third degree. The average duration of arterial hypertension was 6.14 years. Of the total number of subjects, 28% did not take any antihypertensive drugs. A statistically significant association was found between the degree and duration of arterial hypertension with the development of left ventricular hypertrophy. Significant association wasn't found between the degree or duration of arterial hypertension and the heart ejection fraction. Our study have shown strong correlation between the degree and duration of arterial hypertension and the development of left ventricular hypertrophy and ultrasound could be a useful method in the evaluation of some patients with arterial hypertension in the emergency department.

**Key words:** *arterial hypertension, left ventricular hypertrophy, ejection fraction, ultrasound, emergency department*

## Introduction

Arterial hypertension (AH) is one of the leading public health problems and a major independent risk

factor for cardiovascular morbidity and mortality<sup>1</sup>. According to the latest classification criteria of the European Society for Arterial Hypertension (ESH) and the European Society of Cardiology (ESC) from 2018, arterial hypertension is defined by values of systolic arterial pressure  $\geq 140$  mmHg and/or diastolic arterial pressure  $\geq 90$  mmHg measured by calibrated mercury pressure gauge<sup>1,2,3</sup>. The total prevalence of arterial hy-

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hypertension is about 30-45% of the total population, and it grows proportionally with the increase in age<sup>1</sup>. HBP is thought to be responsible in 18% of all deaths<sup>4</sup>. In most of the cases (85-95%) it is essential hypertension with a previously unknown cause, while in 5-15% of the cases it is secondary hypertension<sup>2</sup>. Hypertension is usually asymptomatic until complications develop on the target organs<sup>5,6</sup>. Diagnosis of arterial hypertension involves taking a detailed history-anamnesis, physical examination and laboratory tests. We can divide the diagnostic procedure itself into three steps: determining the height of the blood pressure, assessing the total cardiovascular risk and detecting secondary causes of hypertension<sup>7</sup>. High blood pressure (HBP) is the main risk factor for coronary heart disease, cerebrovascular disease, peripheral artery disease and chronic and final stage kidney disease<sup>2,3</sup>. Therefore, the height of blood pressure (BP) and the duration of arterial hypertension are important<sup>4</sup>. Arterial hypertension of the systemic bloodstream causes pressure load and left ventricular hypertrophy (LVH). LVH represents an important clinical entity because it is associated with an increased risk of cardiac failure, ventricular arrhythmias, development of myocardial infarction, reduction of ejection fraction (EF), sudden cardiac death, dilatation of aortic root and cerebrovascular event occurrence<sup>8,9</sup>. The LVH echocardiographically established and the reduced ejection fraction (EF) are independent predictors of adverse cardiovascular events<sup>10</sup>. Hypertension is considered a lifelong disease and a unique therapeutic problem. If the conservative approach (hygienic-dietary measures, lifestyle changes) proves ineffective, it is switched to pharmacological treatment<sup>11</sup>.

## Subjects and methods

A prospective study included 50 patients with arterial hypertension as leading diagnosis. All 50 patients were consecutively examined in the Emergency Department and then referred to the Cardiac clinic of the Clinical Hospital "Sveti Duh" for further evaluation. The inclusion criteria were male and female aged 18 and older and arterial hypertension as leading diagnosis during Emergency Department visit. Exclusion criteria were pathological conditions that alter architecture and impair heart contractility (dilative cardiomyopathy, severe aortic stenosis, myocarditis, primary amyloidosis,

etc.). The research was approved by the Ethics Committee of the Clinical Hospital "Sveti Duh".

We measured the left ventricle wall thickness (LVWT), based on the thickness of the intraventricular septum (IVS) and the thickness of posterior wall of the left ventricle (LVPW) expressed in centimeters (cm) and the ejection fraction (EF) with the cardiac ultrasound GE Vivid E9. With the specified ultrasonic indicators we compared the degree and the duration of arterial hypertension.

## Statistical methods

The statistical package SPSS 23.0 (IBM Corp., Armonk, NY) was used for data analysis. The distribution of subjects is presented using descriptive statistics, i.e. arithmetic environments with the corresponding standard deviations and the lowest and highest achieved result. Categorical variables are presented as frequencies at the corresponding percentages. To calculate the correlations of continuous variables, the Pearson correlation coefficient was used, while Spearman coefficient was calculated on data of ordinal nature. Statistical inference was carried out at levels 5% and 1%.

## Results

A total of 50 participants participated in the survey, twenty-six were female (52%). The average age of the participants was  $58.70 \pm 13.37$  years. The average duration of HBP was  $6.14 \pm 5.50$  years. According to the degree of classification of arterial hypertension<sup>1,2</sup>, the highest proportion were subjects with the first degree of hypertension (44%), followed by subjects with a third degree (36%), and the smallest have the second stage of arterial hypertension (20%). Of the total number of subjects, 14 of them or 28% did not take any antihypertensive drugs, respectively. In terms of ultrasonic indicators, the ejection fraction in our study averaged  $64.20 \pm 8.07$ . According to the classification criterion, this value is normal if it is 55% or more<sup>12</sup>, and in our study 47 subjects of 50 (94%) had a normal ejection fraction. According to clear cardiac criteria, the thickened IVS wall is  $> 1.2$  cm for men, or  $> 1.1$  cm for women<sup>12</sup>, and in our study it was found that the IVS wall is thickened in just over half of our subjects (N=27). According to the same cardiac criteria, we found that 30% of our sample (N=15) had a thickened posterior wall of the left ventricle, or 41.7% of men

compared to 19.2% of women (Table 1.). From the table of correlations (Table 2.), we note that there is a statistically significant but weak negative correlation of the ejection fraction with the thickness of the left ventricle IVS ( $r=-0.29$ ,  $p<0.05$ ). The value of IVS showed a significant statistical correlation with the degree of arterial hypertension ( $r=0.27$ ,  $p<0.05$ ), with the thickness of IVS and growing with a higher degree of HBP. Furthermore, a moderate significant correlation between the variables LVPW and the duration of arterial hypertension have shown that a higher thickness of LVPW is associated with a longer duration of arterial hypertension ( $r=0.34$ ,  $p<0.05$ ). There is significant positive interdependence between left ventricular hypertrophy (LVH) and LVWT IVS ( $r=0.74$ ,  $p<0.01$ ) and LVWT LVPW ( $r=0.66$ ,  $p<0.01$ ). HBP therapy (defined solely as exists/does not exist), is moderately highly associated with duration of HBP ( $r=0.47$ ,  $p<0.01$ ). There is a statistically significant positive correlation between grade of arterial hypertension and the development of left ventricular hypertrophy ( $r=0.30$ ,  $p<0.05$ ). The probability of developing LVH increases with an increase in BP. There is no statistically signifi-

cant association between the degree of arterial hypertension or the duration of HBP with the heart ejection fraction ( $p>0.05$ ).

## Discussion

The study has shown that arterial hypertension is more common in females (52% vs. 48% in men), what correlates with the literature<sup>3,4</sup>. Regarding age distribution, our research results are consistent with the searched literature<sup>2,3</sup>. Our research has shown that a higher proportion of patients is with high blood pressure levels. A higher proportion of persons with a third degree of HBP, i.e. pressure values  $\geq 180/110$  mmHg could be explained by the fact that a small number of people are aware of their disease. A study conducted in 2003 in Croatia showed that more than 50% of patients were unaware of their illness, 48.4% received treatment, and in only 14.8% of patients achieved satisfactory pressure value<sup>13</sup>. There is a clear correlation between grade of arterial hypertension and its duration with the onset of cardiovascular diseases and incidents,

Table 1. Indicators of LVWT IVS and LVWT LVPW according to cardiac criteria

	LVWT IVS category number of patients N (%) thickened	LVWT LVPW category number of patients N (%) thickened
altogether	27 (54%)	15 (30%)
males (N=24)	12 (50%)	10 (41.7%)
females (N=26)	15 (57.7%)	5 (19.2%)

LVWT – left ventricular wall thickness, IVS – intraventricular septum, LVPW – left ventricular posterior wall.

Table 2. Correlations EF, LVWT IVS, LVWT LVPW, degree, duration and therapy of HBP

	EF (%)	LVWT IVS	LVWT LVPW	duration of HBP	degree of HBP	LVH	therapy of HBP
EF (%)	1	-0.29*	-0.22	-0.04	-0.13	-0.12	0.05
LVWT IVS		1	0.839**	0.23	0.27*	0.74**	0.03
LVWT LVPW			1	0.34*	0.21	0.66**	0.16
duration of HBP				1	-0.08	0.13	0.47**
degree of HBP					1	0.30*	-0.25
LVH						1	0.05
therapy of HBP							1

\*  $p<0.05$ ; \*\*  $p<0.01$

EF-ejection fraction, LVWT-left ventricular wall thickness, IVS-intraventricular septum, LVPW-left ventricular posterior wall, HBP-high blood pressure/arterial hypertension, LVH-left ventricular hypertrophy

while the value of blood pressure and the duration of arterial hypertension is important<sup>4,10,14</sup>. Our research shows that the degree and duration of HBP led to an increase in the left ventricle wall thickness. Those data are important since the literature states that LVH is one of the most important predictors of adverse cardiovascular events<sup>10</sup>. The prevalence of LVH in hypertensive patients ranges from 36 to 41%<sup>15</sup> which is slightly lower than our score, according to which 54% of subjects had LVH. According to the Framingham Heart Study<sup>16</sup>, LVH is often found in the early stages of the disease, which was also observed in our study where the average duration of HBP with signs of LVH was 6.14 years. The study showed that thickening of the left ventricle wall is directly related to the progression of hypertension, and the authors conclude that ultrasonic measurement of LV wall thickness could help determine patients in need of antihypertensive therapy<sup>16</sup>. Laufer E<sup>17</sup> points out in his paper that ultrasonic measurement of LV wall thickness alone can prove LVH in 80% of patients with newly discovered hypertension, although more significant is calculation of the mass of LV in the assessment of patients with left ventricular hypertrophy. The results of our study have shown strong correlation between the degree and duration of arterial hypertension and the development of left ventricular hypertrophy.

As a conclusion, ultrasound could be a useful method in the evaluation of some patients with arterial hypertension in the emergency department. However, this research should continue and be carried out on a larger number of subjects in order to increase the statistical and clinical significance of the use of ultrasound as a fast method of assessing the two indicators investigated (LVWT and EF) in the emergency department.

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## Sažetak

DIJAGNOSTIČKA VRIJEDNOST ULTRAZVUKA SRCA  
U PROCIJENI TRAJANJA ARTERIJSKE HIPERTENZIJE

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Cilj istraživanja je bio uz pomoć ultrazvuka srca procijeniti povezanosti između stupnja i duljine trajanja arterijske hipertenzije te razvoja hipertrofije lijeve klijetke i istisne frakcije srca. Provedeno je prospektivno istraživanje koje je uključivalo 50 bolesnika sa arterijskom hipertenzijom kao vodećom dijagnozom. Svih 50 bolesnika je uzastopno pregledano u Objedinjenom hitnom bolničkom prijemu, a nakon toga upućeno u kardiološku ambulantu Kliničke bolnice „Sveti Duh“ na daljnju obradu. U istraživanje su bili uključeni bolesnici stariji od 18 godina, oba spola, s vodećom dijagnozom arterijske hipertenzije postavljene u Objedinjenom hitnom bolničkom prijemu dok su iz istraživanja bili isključeni bolesnici s patološkim stanjima koja mijenjaju arhitekturu i narušavaju kontraktilnost srca. Ultrazvučno se određivala debljina stijenke lijeve klijetke sačinjena od debljine intraventrikularnog septuma i stražnje stijenke lijeve klijetke te istisna frakcija. Najveći udio ispitanika bio je s prvim stupnjem, a slijedili su ih ispitanici s trećim stupnjem arterijske hipertenzije. Prosječno trajanje arterijske hipertenzije iznosilo je 6.14 godina. Od ukupnog broja ispitanika, 28% nije uzimalo nikakve antihipertenzivne lijekove. Pronađena je statistički značajna povezanost između stupnja i duljine trajanja arterijske hipertenzije s razvojem hipertrofije lijeve klijetke. Nije pronadena značajna povezanost stupnja niti duljine trajanja arterijske hipertenzije s istisnom frakcijom srca. Naša studija pokazala je snažnu povezanost između stupnja i duljine trajanja arterijske hipertenzije i razvoja hipertrofije lijeve klijetke, a ultrazvuk bi mogao biti korisna metoda u procjeni nekih bolesnika s arterijskom hipertenzijom u hitnoj službi.

*Ključne riječi: arterijska hipertenzija, hipertrofija lijeve klijetke, istisna frakcija, ultrazvuk, hitna služba*