

LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN ESSENTIAL HYPERTENSION

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ABSTRACT

TDiastolic dysfunction is very frequent and is actually sign of manifest heart weakness. Over 40% of patients with heart weakness have isolated left ventricular diastolic dysfunction (LVDD). New diagnostics methods as Doppler Echocardiography with close monitoring enables precise and early LVDD diagnose. In all diastolic phases artery hypertension weakens relaxation and left ventricular hypertrophy (LVH) weakens compliance also. The purpose of this study is to demonstrate importance of all LVDD. Doppler echocardiography parameters usage and its important echocardiography characteristic in case of hypertensive patients. This study represents 64 patients with essential hypertension – random sample. Three patients had atrial fibrillation. Besides anamnestic data collection, echocardiography evaluation was undertaken on all patients. For LVDD diagnose following parameters were used: isovolumic relaxation time (IVRT), peak early filling velocity (E), peak atrial filling velocity (A), E/A ratio, DT (deceleration time), left ventricular (LV) mass. Left ventricular hypertrophy (LVH) was verified for 57 patients. Seven hypertensive patients didn't have verified LVH. Comparing patients with LVH with those without LVH differences were observed: patients with LVH had a longer IVRT, lower E/A ratio, A wave growth, IVRT directly correlates with LV mass increase and backward correlation LV mass with E/A was noticed. Among patients with LVH with E/A ratio $\geq 1-1,5$ and based on transmitral flow we used IVRT duration and pulse Doppler with volume sample over lateral mitral annulus measuring mitral annulus velocity. It appeared that it corresponds with IVRT duration in LVDD evaluation. Patients with atrial fibrillation had considerably extended IVRT that indicates LVDD existence. Patients with left ventricular hypertrophy were older and they have higher left ventricular mass comparing with patients without left ventricular hypertrophy. In case of patients with essential hypertension all above mentioned LVDD parameters have to be defined, specially IVRT duration for determination of LVDD existence in case of all patients with essential hypertension with and without LVH and in case of associated atrial fibrillation presence. It is necessary to tend to, as early as possible, detect LVDD and it's prevention with improved essential hypertension monitoring.

KEY WORDS: diastolic dysfunction, essential hypertension, left ventricular hypertrophy, mitral inflow velocity

INTRODUCTION

Diastolic dysfunction (DD) is a sign of manifest heart weakness and higher cardiovascular incidence. In first phase ejection fraction (EF) is preserved but relaxing attributes are being debilitated. The heart rigidity (non-elastic, inflexibility) is warning sign that requires closer echocardiography monitoring. LVDD diagnosis is usually based on: clinical symptoms of heart weakness (particularly left heart), normal EF – over 50 % and diastolic fill pressure growth (4). Diastolic dysfunction has preceding manifestation in form of relaxation disorder or left ventricular inflexibility that is often seen in case of ischemic hart disease or heart muscle hypertrophy. It is necessary to make early diagnose of left ventricular hypertrophy in hypertensive heart disease since it is very important indicator of cardiovascular disease in clinical practice. Enormous left ventricular hypertrophy is major risk factor and it predicts sudden death caused by heart infarct and other cardiovascular “events” (7, 8). It’s prevalence depends of population’s specific characteristics and can be found in 3% of normotensive and around 3/4 hypertensive patients. Left ventricular hypertrophy finding increases with ageing and women have it more often (11). As a response to pressure or volume strain in hypertensive heart disease left ventricular hypertrophy develops in concentric or eccentric form. In a case of pressure strain on heart left ventricular hypertrophy develops with wall thickening occasionally slightly increased inner dimensions left ventricular concentric form. Volume strain is followed by exocentric left ventricular hypertrophy with increase of left ventricular cavern too (i.e. obesity). The most reliable method to diagnose left ventricular hypertrophy is noninvasive technique in most cases and Doppler echocardiography for left ventricular diastolic function evaluation specially using Tissue Doppler for early diagnose of left ventricular diastolic dysfunction even before its identified through transmitral flow (6, 9). Hypertension weakness relaxation and left ventricular hypertrophy lowers compliancy on all diastole phases. Left ventricular hypertrophy causes myocardial mass increase by increasing mass of

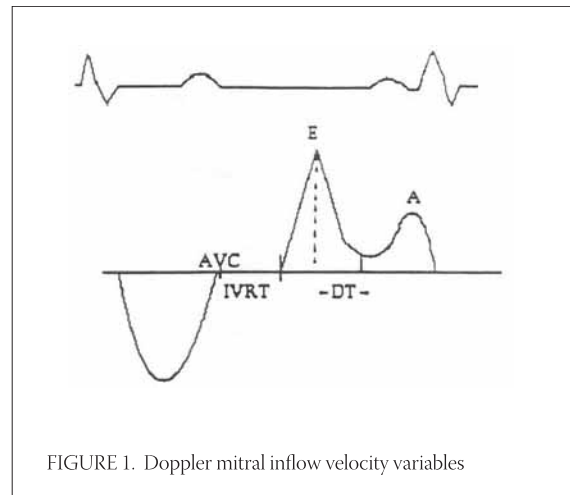


FIGURE 1. Doppler mitral inflow velocity variables

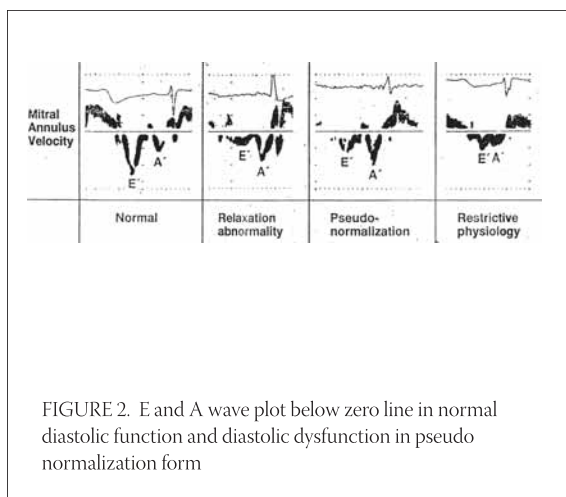
connective tissue around myocyte /extracelular matrix/. This all slows down myocardial relaxation and increases it’s rigidity in case of hypertensive heart disease and leads to left ventricular diastolic dysfunction. Diastolic function is specified by parameters shown on Figure 1. The purpose of this study is to prove importance of utilization all Doppler echocardiography parameters left ventricular diastolic dysfunction and to point important echocardiography characteristics of it in case of hypertensive heart disease (5).

SUBJECTS AND METHODS

The research is prospective and involved 64 patients with essential arterial hypertension / random sample / of which 23 man and 41 woman. Values over 140/90mmHg were considered as high blood pressure. Criteria for exclusion out of the study for possible affect on diastolic function were conditions as: ischemic heart disease, diabetes mellitus, valvular heart disease, heart weakness – systolic function lower then 50%. During the examination performed in House of Health Tuzla hypertensive patients were placed under anthropometric measurement weight and height followed by (body mass index)BMI calculation for every patient. Anamnestic data of other risk factors presence were taken, the hypertension duration. Afterward patients were echocardiography examined by ultrasound

Following parameters are important for determination of left ventricular diastolic function by Tissue Doppler:

LABEL	DEFINITION	NORMAL RANGE
E	- peak early filling velocity	0,8 ± 0,2 m/s
A	- peak atrial filling velocity	0,5 ± 0,2 m/s
E/A	- ratio	≤ 1,5
IVRT	- isovolumic relaxation time	70±12ms /< 110-abnormal relaxation
	- time from aortic valve closure (AVC) to onset of mitral flow	> 60- restrictive /
DT	- deceleration time	160-210 ms



color Doppler apparatus SIEMENS SONOLAJN G50. Following parameters were measured for patients in log axis view in M mode and 2 D:

- IVSd /IVSTD/ (Interventricular Septum Thickness in Diastole)
- LVIDd /LVIDD/ (Left Ventricular Internal Diameter in Diastole -on mitral valve horde level)
- PLWd /PWTD/ (Posterior Wall Thickness in Diastole)
- LVIDs (Left Ventricular Internal Diameter in Systole -on mitral valve horde level)
- LA (left atrium)
- LVmass – left ventricular mass – three possible ways of calculation: (Troy, Devereux and Levy and associates in Framingham's study).

Devereoux's formula for LV mass calculation chosen:
 $LVmass (Penn) = 1,04 ([LVIDD + PWTD + IVSTD]^3 - [LVIDD]^3) - 13,6 g$

Ejection fraction is measured by Simpson. Parameters that are defining diastolic function were measured by pulse Doppler in 4 chamber view and with volume sample on top of the mitral leafs. Measured values are on Figure 1:

- IVRT (isovolumic relaxation time – time from aortic valve closure to onset of mitral flow)
- E wave (peak early filling velocity)
- A wave (peak atrial filling velocity)
- E/A (ratio)
- DT (deceleration time-time from top of the E wave to point where it cuts zero line)

When left ventricular hypertrophy exists and where E/A is 1-1,5 pulse Doppler volume sample was positioned on mitral ring lateral portion based on which we got

the difference between normal mitral flow and diastolic dysfunction in form of pseudo-normalization. In normal form E wave stayed higher then A wave while in case of pseudo normalization A wave became higher then E wave below zero line of shown mitral flow (Figure 2). Afterward, statistical data processing was performed.

RESULTS

Of 64 patients involved in this study 41 patients were female and 23 of male sex. 57 patients had left ventricular hypertrophy. Of 57 patients with left ventricular hypertrophy 42 had diastolic dysfunction (form of abnormal relaxation and pseudo normalization, no restriction). 15 had normal left ventricular diastolic function, 7 patients didn't have left ventricular hypertrophy. Other characteristics are listed in Table 1. Parameters of diastolic function IVRT, E wave, A wave, E/A ratio and DT were observed on all patients. Significantly longer IVRT was in case of patients with LVH compared to patients without LVH. E/A ratio were lower in case of diastolic dysfunction with LVH compared to patients without LVH. A wave was higher in group with LVH where left ventricular diastolic dysfunction existed. BMI and EF didn't have considerable difference in both groups. In group with LVH number of smokers was significantly higher. In group of 10 patients with diastolic dysfunction with E/A=1-1,5 by IVRT endurance we distinguished normal left ventricular diastolic function from left ventricular diastolic dysfunction form of pseudo normalization. By IVRT endurance we found diastolic dysfunction in 4 such patients. See Figure 3 and 4 3 patients were diagnosed with atrial fibrillation. All of them had extended IVRT. See Figure

	With HLV	Without HLV
Total	57	7
Man	22	1
Women	36	6
Systolic pressure	167	140
Diastolic pressure	97	94
Years of age	57	46
Hypertension endurance /year/	8	3
BMI/ITM/	28	29,5
Smokers	11	1
IVRT	147	91
E/A ratio	0,69	1,14
DT	184	167
EF	63,4	62,2
A wave	0,79	0,60
LV mass	299,49	186,4

TABLE 1. Clinically important facts on examined patients

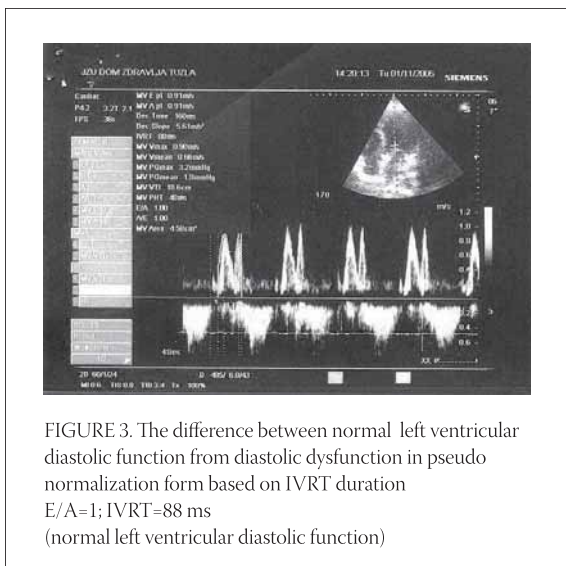


FIGURE 3. The difference between normal left ventricular diastolic function from diastolic dysfunction in pseudo normalization form based on IVRT duration
E/A=1; IVRT=88 ms
(normal left ventricular diastolic function)

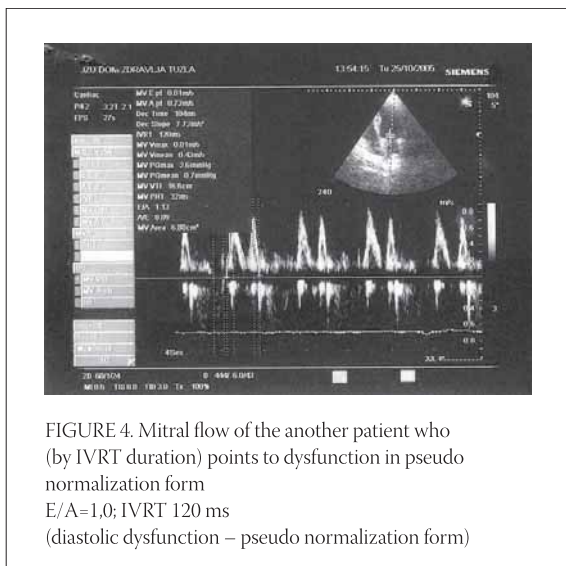


FIGURE 4. Mitral flow of the another patient who (by IVRT duration) points to dysfunction in pseudo normalization form
E/A=1,0; IVRT 120 ms
(diastolic dysfunction – pseudo normalization form)

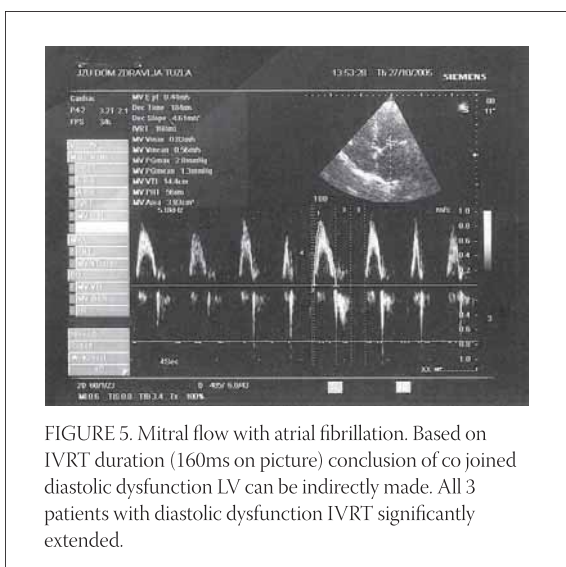


FIGURE 5. Mitral flow with atrial fibrillation. Based on IVRT duration (160ms on picture) conclusion of co joined diastolic dysfunction LV can be indirectly made. All 3 patients with diastolic dysfunction IVRT significantly extended.

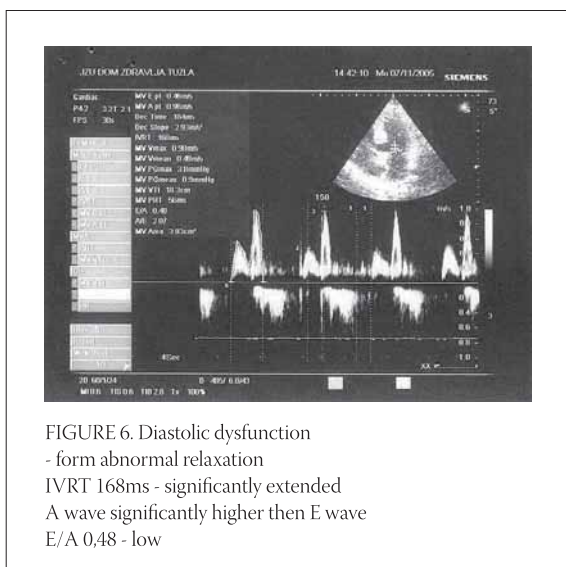
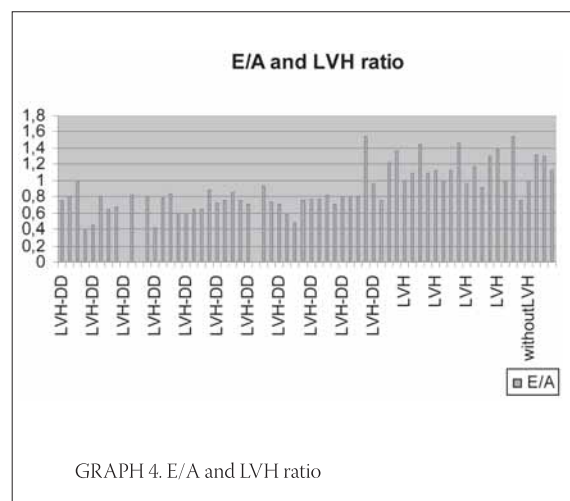
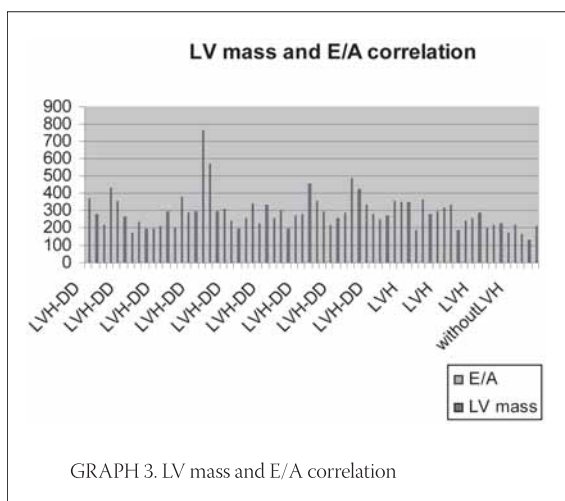
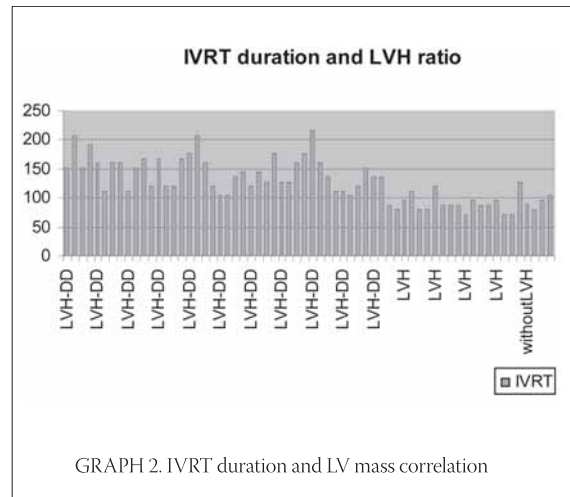
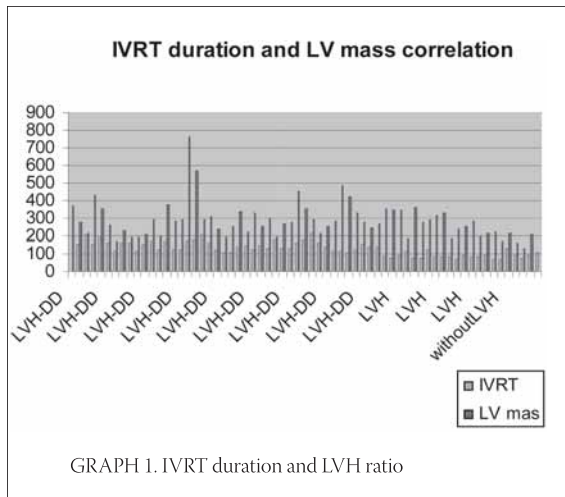


FIGURE 6. Diastolic dysfunction - form abnormal relaxation
IVRT 168ms - significantly extended
A wave significantly higher then E wave
E/A 0,48 - low

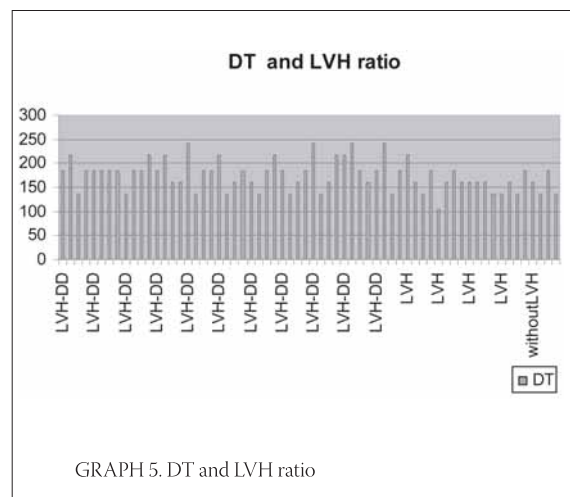
5. Of 42 patients with diastolic dysfunction 38 patients had diastolic dysfunction – form abnormal relaxation. See Figure 6. Direct correlation between IVRT duration and LV mass was detected (Graph 1). IVRT significantly longer in case of patients with HLV with diastolic dysfunction compare to patients without diastolic dysfunction and patients without HLV (Graph 2). Opposite correlation between LV mass and E/A was noticed too (higher LV mass lower E/A ratio). (Graph 3). Significantly lower E/A in patients with LVH with diastolic dysfunction LV compare to patients with LVH without diastolic dysfunction and without LVH is evident. (Graph 4). DT doesn't show statistically higher values in patients with LVH compared to patients without LVH (Graph 5).

DISCUSSION

Left ventricular diastolic dysfunction is frequent in case of essential hypertension, older people, ischemia, obese woman and diabetics. Diastolic heart weakness prevalence rises with age. Framingham's study gave prognosis meaning to LVH (enlarged LV mass). It is associated with enlarged risk of sudden death, death caused by cardiovascular disease, independent of other risk factors (3, 7) LV mass enlarged for 50 gram increases risk of sudden death almost twice. Our examination involved 64 patients with arterial hypertension including 57 patients with LVH and 7 patients without LVH. Of 57 with LVH 42 patients had diastolic dysfunction and 15 were with normal left ventricular diastolic function based on random sample. Patients with LVH were significantly older



compare to patients without LVH and had significantly higher systolic pressure and significantly longer hypertension endurance – 8 years hypertension endurance for patients with LVH and 3 years for patients without LVH. It means hypertension endurance is important for diastolic dysfunction develop. Patients with LVH and with normal diastolic function had longer hypertension endurance for 8,5 years compare to patients with LVH with normal diastolic function for 6,4 years. Arterial hypertension and LVH are risk factors that are causing disorder in left ventricular diastolic function / this matches to literature data (1, 2). Patients BMI with or without LVH were not significantly different as well as value of EF. Diastolic dysfunction parameters in patients with LVH compare to patients without LVH shown significantly longer IVRT, A wave is higher, E/A ratio is smaller. IVRT directly correlate with LVmass which means longer IVRT = higher LV mass/. Study proved that LVH impacts on IVRT extension and E/A ratio decrease in diastolic dysfunction develop. This is why patients with LVH and atrial fibrillation with extended IVRT probably have diastolic dysfunction



(10). IVRT duration in patients with LVH where the E/A ratio is $E/A \geq 1-1,5$ based on transmittal flow and in lack of Tissue Doppler was difficult to determine if it is normal form of diastolic function or diastolic function disorder pseudo normalization type we used IVRT duration and pulse Doppler with volume sample over lateral mitral annulus measuring mitral annulus velocity. Mitral Annulus Velocity (VTI) matches with IVRT

duration in diastolic dysfunction LV evaluation since the result is various flow plot below zero line at normal diastolic function and diastolic dysfunction pseudo normalization form (Figure 2). Enlarged LV mass is

in inverse proportion with E/A ratio (higher LV mass lower E/A ratio). DT and E wave were not significantly statistically different in patients with and without LVH.

CONCLUSION

The number of patients with LVH was significantly higher and they were significantly older, with more women patients. Patients with LVH have higher LV mass compare to patients without LVH and longer hypertension endurance. In patients with LVH and left ventricular diastolic dysfunction IVRT was extended and E/A ratio lower compare to patients without LVH. IVRT is important to distinguish normal transmittal flow from pseudo normal form of left ventricular diastolic dysfunction based on its duration. In all hypertensive patients all mentioned left ventricular diastolic function parameters have to be determined, particularly IVRT duration for left ventricular diastolic function detection in all hypertensive patients with or without LVH and in case of co-joined atrial fibrillation. It is necessary to seek earlier left ventricular diastolic dysfunction diagnosis and its prevention with improved essential hypertension monitoring.

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