

Treated arterial hypertension – which echocardiographic parameters should we monitor? [4]

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ABSTRACT

Aims: To identify discriminatory parameters of left ventricular systolic and diastolic function in a group of patients with treated arterial hypertension (HTN).

Methods and Results: 95 patients with treated essential HTN, recruited from a cardiology outpatient clinic, with a regular follow-up of at least one year, were evaluated with conventional echocardiography and pulsed tissue Doppler imaging (TDI). The patients were divided into 2 groups: A) controlled HTN and B) uncontrolled HTN. Peak systolic (Sm) and early diastolic (Em) myocardial velocities and the ratio of mitral inflow E wave to Em (E/Em) were assessed. All patients had preserved ejection fraction. TDI study was consistent with impaired systolic and diastolic parameters in patients with uncontrolled HTN: septal Sm (cm/s) 7.8 ± 1.8 vs. 6.8 ± 2.2 ($p=0.004$); lateral Sm (cm/s) 9.1 ± 2.8 vs. 7.7 ± 1.7 ($p=0.001$); septal Em (cm/s) 7.9 ± 1.8 vs. 6.8 ± 1.8 ($p=0.002$); lateral Em (cm/s) 9.9 ± 2.8 vs. 8.23 ± 2.7 ($p=0.002$); mean E/Em 8.7 ± 2.2 vs. 10.8 ± 3.9 ($p=0.002$).

Conclusion: In patients with uncontrolled HTN there are echocardiographic parameters that identify early changes in systolic function (reduction in septal and lateral Sm, with preserved ejection fraction) and

RESUMO

Hipertensão arterial medicada e controlo tensional – que parâmetros ecocardiográficos pesquisar?

Objectivo: Identificar parâmetros discriminatórios da função sistólica e diastólica do ventrículo esquerdo num grupo de doentes com hipertensão arterial (HTA) medicada.

Métodos e resultados: 95 doentes com hipertensão arterial essencial medicada, seguidos de forma regular há pelo menos um ano em consulta de cardiologia foram avaliados por ecocardiografia convencional e Doppler tecidual pulsado (TDI). Os doentes foram divididos em dois grupos: A) HTA controlada e B) HTA não controlada. As velocidades miocárdicas de pico sistólico (Sm) e diastólico precoce (Em) bem como o *ratio* da onda E do fluxo de enchimento mitral com Em (E/Em) foram avaliados. Todos os doentes tinham fracção de ejeção preservada. O estudo TDI mostrou uma redução dos parâmetros sistólicos e diastólicos em doentes com HTA não controlada: Sm septal (cm/s) 7.8 ± 1.8 versus 6.8 ± 2.2 ($p=0.004$); Sm lateral (cm/s) 9.1 ± 2.8 versus 7.7 ± 1.7 ($p=0.01$); Em septal (cm/s) 7.9 ± 1.8 ver-

diastolic function (with a reduction in septal and lateral Em). Regular monitoring of these parameters in hypertensive patients enables early identification of changes that may have repercussions on hypertension control.

Key words

Treated hypertension; Echocardiography; Tissue Doppler imaging; Left ventricular function.

sus. 6.8 ± 1.8 ($p=0.002$); Em lateral (cm/s) 9.9 ± 2.8 *versus* 8.2 ± 2.7 ($p=0.002$); E/Em médio 8.7 ± 2.2 *versus* 10.8 ± 3.9 ($p=0.002$).
Conclusão: Em doentes com HTA não controlada há parâmetros que identificam alterações precoces da função sistólica (redução do Sm septal e lateral, com fracção de ejeção mantida) e diastólica (com redução do Em septal e lateral). A monitorização seriada destes parâmetros em doentes hipertensivos permite a identificação precoce de alterações que podem ter repercussão no controlo tensional.

Palavras-Chave

Hipertensão arterial medicada; Ecocardiografia, Doppler tecidual; Função ventricular esquerda.

INTRODUCTION

In recent decades hypertension has been confirmed as a very strong predictor of long-term risk for heart failure^(1,2). Indeed, the older the population, the higher the prevalence of hypertension, while the risk of cardiovascular disease (CVD) increases independently of other risk factors⁽²⁾.

Antihypertensive treatment not only controls hypertension and decreases the rate of acute complications (such as myocardial infarction or stroke) but also reduces the incidence of heart failure^(2,3).

Echocardiography, with its new derived techniques such as tissue Doppler imaging (TDI), provides a more detailed characterization of left ventricular (LV) function. TDI is in fact a very useful tool to evaluate LV diastolic function (and characterize diastolic dysfunction) (4, 5) as well as to detect systolic impairment in patients with normal ejection fraction (>50%).

In the early stages of hypertension systolic and diastolic markers of dysfunction may already exist despite normal or near normal ejection fraction⁽⁶⁾, and this may be clinically

relevant as these patients are at increased risk of developing CVD.

In patients under antihypertensive medication it is crucial to understand which echocardiographic parameters are most useful in monitoring the impact of hypertension on diastolic and systolic function, as they may indicate the need to optimize medication, thereby preventing progression to overt CVD.

METHODS

Study population

We studied 95 patients (42% female:58% male), aged 59.3 ± 11 years, body mass index (BMI) of 27.5 ± 3.9 kg/m², with known and treated essential arterial hypertension (HTN), recruited from the cardiology outpatient clinic, where they had had a regular follow-up of at least 12 months.

HTN was defined as systolic blood pressure of at least 140 mmHg and/or diastolic blood pressure of at least 90 mmHg or normal blood pressure under antihypertensive treatment. Blood pressure control was assessed by 24-hour ambulatory blood pressure monitor-

ing, and when this test was not available the outpatient clinic registry was used (blood pressure during consultation and the patients' own blood pressure monitoring).

The group was divided into two subgroups according to blood pressure control:

Group A – controlled HTN (48 patients – 51%)

Group B – uncontrolled HTN (47 patients – 49%).

All patients were in NYHA class I.

Concerning underlying disease, 18 patients (19%) had type 2 diabetes mellitus (DM), 60 (63%) had dyslipidemia, 19 (20%) were current smokers, 2 (2%) had moderate alcohol consumption, 2 (2%) had asthma, 5 (5%) had hypothyroidism, 6 (6.3%) had a previous history of stroke and 4 (4.2%) had peripheral artery disease. Regarding antihypertensive medication, beta-blockers were the most frequently prescribed (47 patients – 49.5%), followed by diuretics (45 patients – 47%) and angiotensin receptor antagonists (42 patients – 44%).

The only underlying disease that was statistically more prevalent in group B was type 2 DM (3 patients in group A vs. 15 in group B – $p=0.001$). Diuretics were the only class of antihypertensive medication that was statistically more prevalent in group B (17 patients in group A – 35% vs. 28 in group B – 60%, $p=0.02$).

The following exclusion criteria were used: secondary hypertension, valvular or coronary artery disease, chronic renal failure (creatinine >2 mg/dL), or rhythm other than sinus rhythm.

Echocardiography

All patients were evaluated by standard 2-dimensional and Doppler echocardiography in left lateral decubitus using a General Electric Vingmed Ultrasound Vivid 7 scanner with a 1.75-3.5 MHz probe.

All images were recorded using second harmonic imaging. The collected data was stored on the EchoPAC and analyzed off line. Left ventricular dimension and ejection fraction were measured using a 2-dimensionally

guided M-mode method. LV mass was obtained by the area-length formula and the LV mass index was obtained by the ratio between LV mass and body surface area.

Relative wall thickness was obtained by the following formula:

$$\frac{2 \times \text{posterior wall thickness}}{\text{LV end-diastolic diameter}}$$

Pulsed wave transmitral flow was obtained in apical four-chamber view with the sample positioned at the level of the mitral valve tips. E and A velocities, E/A ratio, deceleration time (DT) and isovolumetric relaxation time (IVRT) were obtained.

Pulsed wave TDI of the septal and lateral walls of the LV were recorded in apical four-chamber view. The sample was placed at the mitral annulus and an average of three consecutive cardiac cycles were recorded. Peak Sm, Em and Am velocities, Em/Am and E/Em ratios were acquired. Mean Em was calculated as the average between septal Em and lateral Em.

Statistical analysis

The data were analyzed using SPSS version 13.0. Continuous variables expressed as mean \pm SD were compared using the Student's t test for independent groups, or when the assumption to use this test was not satisfied the Mann-Whitney test was used. Categorical variables were compared using the chi-square test.

A value of $p<0.05$ was considered significant.

RESULTS

The patient characteristics are listed in Table I.

Echocardiographic results are listed in Table II. All patients had preserved left ventricular ejection fraction. Posterior wall diameter was slightly but significantly smaller in the controlled HTN group, as was relative wall thickness. E/A ratio was also statistically higher in this group.

Tissue Doppler imaging

In controlled hypertensive patients lateral

Table I. Characteristics of the study population

	Group A (n=48)	Group B (n=47)	p
Age (years)	57±10	62±11	0.06
Female (%)	16 (33)	24 (51)	0.08
Body mass index (kg/m ²)	27±3.9	27.8±4	0.60
Systolic blood pressure (mmHg)	134±16	150±15	<0.01
Diastolic blood pressure (mmHg)	78±9	84±9	0.03
ACE inhibitors (%)	11 (23)	17 (36)	0.16
Angiotensin receptor antagonists (%)	19 (40)	23 (49)	0.36
Beta-blockers (%)	22 (46%)	25 (53)	0.47
Diuretics (%)	17 (35)	28 (60)	0.02
Calcium channel antagonists (%)	9 (19)	15 (32)	0.14
Type 2 diabetes mellitus (%)	3 (6)	15 (32)	<0.01
Dyslipidemia (%)	27 (56)	33 (70)	0.6
Smoking (%)	7 (15)	12 (26)	0.18
Alcohol (%)	2 (4)	0	0.5
Dipper (%)	28 (78)	16 (73)	0.66
Creatinine (mg/mL)	0.99±0.3	0.96±0.3	0.14
Heart rate (cycles/second)	65±12	68±9	0.06
Hyperuricemia (%)	6 (13)	11 (23)	0.17

Table II. Parameters derived from 2D, M-mode and transmitral flow Doppler echocardiography in patients with controlled and uncontrolled reated hypertension

	Group A	Group B	p
Left atrial volume (cm ³)	17.8±4	18.3±4	0.62
Right atrial volume (cm ³)	12.8±2.5	12.5±3	0.67
LV end-diastolic diameter (mm)	50±5	50±4	0.97
LV end-systolic diameter (mm)	31±5	31±4	0.81
Interventricular septum thickness (mm)	11±4	12±7.7	0.87
Posterior wall thickness (mm)	10±2	11±1.6	0.02
LV mass indexed to body surface (g/m ²)	105.6±25	111±25	0.29
Relative wall thickness	0.41±0.12	0.43±0.07	0.02
Mitral E velocity (cm/s)	76±15	77±21	0.66
Mitral A velocity (cm/s)	68±16	78±24	0.06
Mitral E/A ratio	1.15±0.3	1±0.3	0.03
A duration (ms)	144±33	140±33	0.44
Deceleration time (ms)	231±62	246±55	0.12
IVRT (ms)	92±17	89±18	0.34
PV (cm/s)	55±20	51±20	0.32
E/PV	1.6±0.6	1.8±0.8	0.7
Septal LV systolic thickening (mm)	14±2	13±2.9	0.12
Lateral LV systolic thickening (mm)	16.5±3	16±3	0.21
Anterior LV systolic thickening (mm)	24.4±4	23±4.5	0.23

IVRT: isovolumetric relaxation time; LV: left ventricular; PV: propagation velocity

and septal Sm and Em velocities were significantly different from those with uncontrolled hypertension. Septal and lateral Sm velocities were higher in the first group, while the latter also had lower Em peak velocities, reflecting altered systolic and diastolic function. On the other hand, E/Em indices (lateral, septal and mean) are significantly higher in the uncontrolled hypertensive patients, revealing higher filling pressures in this group (Table III and Figure 1).

DISCUSSION

In this article, we evaluated left ventricular systolic and diastolic dysfunction in 95 patients with treated arterial hypertension, using conventional and new derived echocardiographic techniques such as tissue Doppler imaging (TDI). Even though all patients had preserved ejection fraction and all were under treatment, TDI identified significant changes in both systolic and diastolic function in patients whose blood pressure was not controlled.

Table III. Parameters derived from tissue Doppler imaging in patients with controlled and uncontrolled hypertension

	Group A	Group B	p
Lateral wall			
Sm (cm/s)	9.1±2.8	7.7±1.7	0.01
Em (cm/s)	9.9±2.8	8.2±2.7	0.002
Am (cm/s)	11.2±3.2	10.7±2.7	0.46
Em/Am	0.9±0.3	0.8±0.3	0.03
Septum			
Sm (cm/s)	7.8±1.8	6.8±2.2	0.004
Em (cm/s)	7.9±1.8	6.8±1.8	0.002
Am (cm/s)	10.4±2.5	9.6±2.7	0.05
Em/Am	0.8±0.3	0.7±0.3	0.02
Mean Em (cm/s)	8.8±1.9	7.6±1.9	0.003
Lateral E/Em	10.1±3.2	12.4±5.3	0.03
Septal E/Em	7.9±2.5	9.9±3.8	0.002
Mean E/Em	8.7±2.2	10.8±3.9	0.002

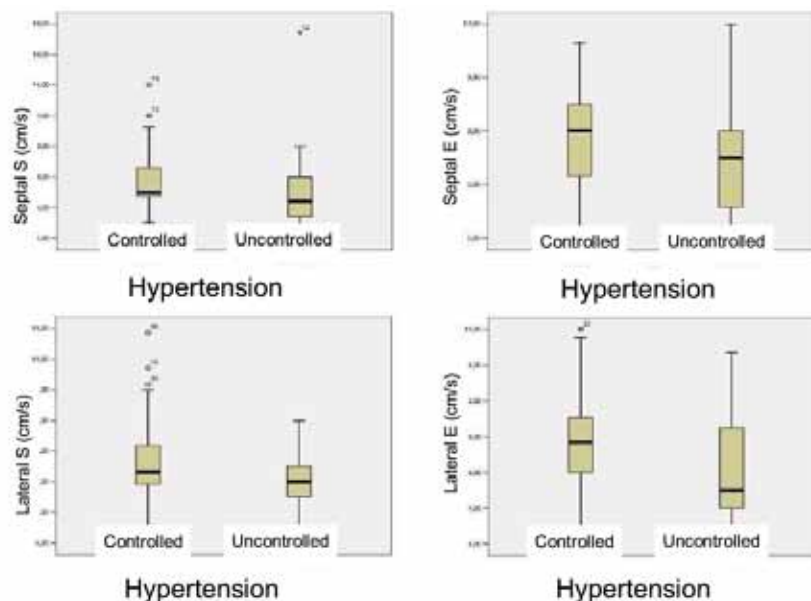


Figure 1. Tissue Doppler parameters that differ significantly between the groups: septal Sm and Em, and lateral Sm and Em.

Lateral and septal LV Sm were decreased in uncontrolled hypertensive patients, despite their having preserved ejection fraction. Additionally, diastolic evaluation revealed that these patients had higher mitral A peak velocities that resulted in lower mitral E/A ratios. TDI study revealed decreased peak Em velocities, both septal and lateral. This shows that there is also disturbed diastolic cardiac function when hypertension is under treatment but not controlled.

Also, mean septal, lateral and E/Em ratios were higher in the uncontrolled hypertensive population, which reveals higher filling pressures in these patients.

Other studies have revealed that in the general population, TDI parameters are lower in hypertensive patients (8). In this study we show that using a noninvasive method of evaluating a population of hypertensive patients, those that have controlled blood pressure have less impact on systolic and diastolic cardiac

function. This is extremely important from a clinical point of view, since these parameters can be used to monitor hypertensive patients under treatment to identify early changes in both systolic and diastolic function and to justify more aggressive measures to control blood pressure.

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