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# Some Questions Concerning Non Invasive Diagnosis In Arterial Hypertesion

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## Citation

A Milan. *Some Questions Concerning Non Invasive Diagnosis In Arterial Hypertesion*. The Internet Journal of Cardiovascular Research. 2005 Volume 3 Number 1.

## Abstract

This study was designated to find and to characterize similarities and differences between two groups of patients. One group were patients with established arterial hypertension / AH / and the second one were patients with new diagnosis of AH or who have so called high normal blood pressure.

The main goal of the study was to show that the groups are similar in important parameters, which may be of clinical importance and to find which of the non invasive examinations, with exception of classical blood pressure / BP / measurements, may still play the important role in setting the diagnosis of AH in early stage of the disease.

Following methods and measurements were used due to obtain necessary parameters – arterial blood pressure measurement, echocardiographic examination to obtain values as left ventricular diameter in systole and diastole, interventricular septum and posterior wall thickness in systole and diastole, ejection fraction - Teichholz, interventricular septum and posterior wall excursions, left atrial diameter, measurement of speed of aortic ejection, E/A index, isovolumic relaxation time, carotid intimal thickening, carotid pulse velocity, time to peak of carotid upstroke and ambulatory blood pressure and electrocardiogram monitoring, measurement of blood pressure reaction on exercise stress testing and in recovery period post exercise and double product.

## INTRODUCTION

Essential arterial hypertension / AH / is the main risk factor in the development of atherosclerosis. At the present time we have possibility to diagnose AH at the early stage of disease.

It is known that AH is as the atherosclerosis the self perpetuating process. So, when we have qualified suspicion on this disease we should immediately start with antihypertensive therapy.

In this work is shown that between patients with new diagnosis of AH or who have so called normal high blood pressure and patients with defined diagnosis of AH exist great similarity in observed parameters, especially in blood pressure reaction on exercise and in the development of blood pressure in recovery phase post exercise.

Thirtysix patients, otherwise healthy as to the cardiovascular system, with less or more elevated blood pressure at admission or at history and onehundredsix patients with diagnosis of hypertensive arterial disease were studied. Under normal conditions the patients from the first group

would be recommended only to change and improve their lifestyle, as to the increase their physical activity, sufficient relaxation, stress reduction, body weight reduction, salt intake lowering etc. And they are summoned to checks of their BP after certain time periods. But we should be more active in this situation.

It was decided to put these patients through all of these above mentioned examinations inclusive exercise stress testing in order to find certain differences or similarities on noninvasive examination between both groups.

## METHODS

Following parameters were measured – arterial blood pressure, echocardiographic values as left ventricular diameter in systole and diastole, interventricular septum and posterior wall thickness in systole and diastole, ejection fraction - Teichholz, interventricular septum and posterior wall excursions, left atrial diameter, speed of aortic ejection, E/A index, isovolumic relaxation time, carotid intimal thickening, carotid pulse velocity, time to peak of carotid upstroke and ambulatory blood pressure and

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electrocardiogram monitoring, blood pressure reaction in single stages of exercise stress testing and in single stages of recovery period post exercise, double product.

The results were analysed by means of Student's t-test and the median and frequency rates were determined for different graphs.

**RESULTS**

Baseline characteristics of the patients of both groups are presented in Table 1. Group 1 are patients with chronic AH, group 2 are patients with new diagnosis of AH. Light but statistically significant difference between the groups was found only in the following parameters – IVSD, IVSS, PWD, PWS, LA, E/A, CMIT, patient's age.

**Figure 1**

Table 1: Comparison of data values in both groups of patients

Variable	t-tests, grouped new and chronic AH = st(v3=3, 1,2)(Data)												
	1 – new diagnosis AH		2 – chronic AH		t	sv	p	Nu.val. 1	Nu.val. 2	S.dev. 1	S.dev. 2	F-ratio dispers.	p dispers.
Averag 1	Averag 2												
LVS	32.38893	31.1318203	140	0.189583	36	106	5.9442467	5.5942147	1.228944	0.481752			
LVD	49.77778	49.00943	0.653098	140	0.514788	36	106	6.2614974	6.043495	1.073448	0.761626		
IVSD	10.83333	12.01887	-3.91511	140	0.00141	36	106	1.7947338	1.499095	1.385818	0.208913		
IVSS	14.62778	15.91508	-3.7272	140	0.00028	36	106	2.0630927	1.8828445	1.206628	0.474202		
PWD	9.81667	11.25474	-4.20538	140	0.00048	36	106	1.9821417	1.53102	1.642474	0.056778		
PWS	13.86111	15.34808	-3.84188	140	0.00189	36	106	2.016407	2.0049578	1.01444	0.93048		
EFTCH	62.97222	66.41509	-1.82961	140	0.069587	36	106	10.546458	9.483882	1.236884	0.408914		
eIVS	8.25	7.086538	-3.02109	138	0.00303	36	104	1.1051628	1.527188	1.90944	0.031328		
ePW	11.55556	11.38678	0.539583	140	0.590341	36	106	1.5936381	1.8304878	1.046781	0.905934		
LA	38.11111	36.04151	-2.5395	140	0.00243	36	106	6.084452	4.833883	1.608293	0.022842		
Ao	1.183333	1.238589	-1.28708	140	0.201191	36	106	0.1874888	0.2380774	2.021018	0.01945		
E/A	1.444444	1.266038	-3.81118	140	0.000423	36	106	0.1725443	0.9295918	1.444751	0.215128		
IVRT	0.103333	0.110394	-1.91281	138	0.057832	36	104	0.0210443	0.0183788	1.311402	0.287207		
CMIT	0.06281	0.070804	-3.11458	140	0.001844	36	106	0.0129487	0.0124178	1.087389	0.75981		
CPV	0.133388	0.135802	-0.68734	140	0.486745	36	106	0.0170218	0.0182333	1.147434	0.658803		
TTP	0.200472	0.205123	-0.7162	140	0.475081	36	106	0.0322982	0.0341023	1.114833	0.73108		
aveBPexesS	215.4815	215.5338	-0.01278	140	0.998938	36	106	20.513082	21.504613	1.098008	0.770434		
aveBPexesD	122.3542	121.0715	0.438687	140	0.663028	36	106	15.17193	15.24508	1.09867	1		
aveBPrecS	175.2421	177.5238	-3.52518	140	0.00284	36	106	22.210074	22.609508	1.036292	0.934552		
aveBPrecD	109.5138	105.9953	1.125868	140	0.262108	36	106	15.670371	16.372232	1.081584	0.78891		
Age ave.	51.08333	60.60953	-4.17078	138	0.000054	36	104	12.836054	11.488092	1.953238	0.38210		

Legend : LVS and LVD – left ventricular diameter in systole and diastole, IVSD, IVSS, PWD and PWS – interventricular septum and posterior wall of left ventricle in systole and diastole, EFTCH – ejection fraction Teichholz, eIVS and ePW – excursions of IVS and PW, LA – left atrium diameter, Ao – speed of aortic ejection, E/A index – filling of left ventricle, IVRT – isovolumic relaxation time, CMIT – carotid myointimal thickening, CPV – carotid pulse velocity-time to upstroke of carotid pulse wave, TTP – time to peak of carotid pulse wave, aveBPexesS, aveBPexesD – average of BP in systole and diastole at the end of exercise, aveBPrecS, ave BP recD – average BP in systole and diastole during recovery period, Age ave – average age. T – test characteristic, sv – degree of freedom, p – dispersion, Nu.val. – number of valid, S.dev. – standard deviation, F-ratio disper.- ratio of dispersion /

**AMBULATORY BLOOD PRESSURE**

**MONITORING**

29 patients, i.e. 30,5% of one's from the group with diagnosed AH had maximal levels of BP during monitoring period lower than 140/90mmHg.

21 patients, i.e. 40,6% of one's from the group with new diagnosis of AH had maximal levels of BP during period of monitoring lower than 140/90mmHg. Blood pressure under 140/90mmHg on Holter BP monitoring is almost unremarkable.

Ambulatory electrocardiogram monitoring in both groups was, with exception of unfrequent supraventricular and ventricular extrasystoles, unnoticeable.

**DATA FROM TRANSTHORACALECHOCARDIOGRAPHY**

53 patients , i.e. 40% from the group with diagnosed AH had left ventricular hypertrophy/ IVS and PW thickness above 12mm.

7 patients, i.e. 15,5% from the group with new diagnosed AH had left ventricular hypertrophy.

24 patients, i.e. 25% from the group with diagnosed AH had enlarged left atrium / more than 40mm.

7 patients, i.e. 14,6% from the group with new diagnosed AH had enlarged left atrium.

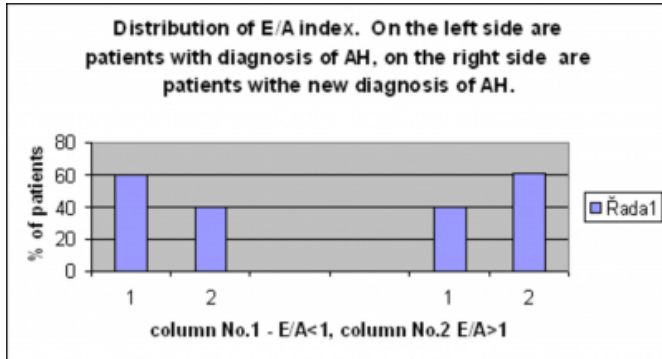
Ejection fraction was in normal limits in both groups.

E/A index - filling of left ventricle was less than one in 60% of patients in the group with diagnosed AH and in 39,6% in the group with new diagnosed AH.

Furher data and results are introduced on the following figures.

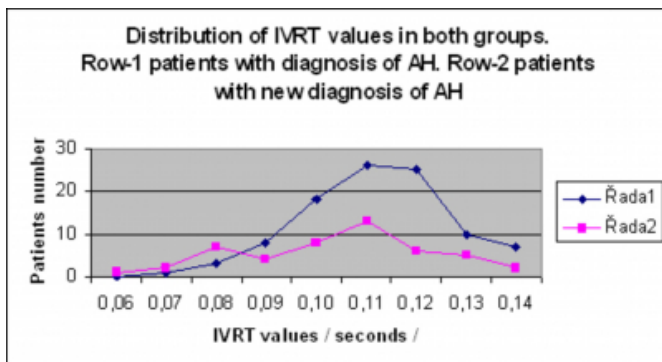
**Figure 2**

Figure 1: Distribution of the E/A index in both groups. 60% of patients from the group with diagnosed AH and 40% of ones with new diagnosis of AH had abnormal E/A filling index.



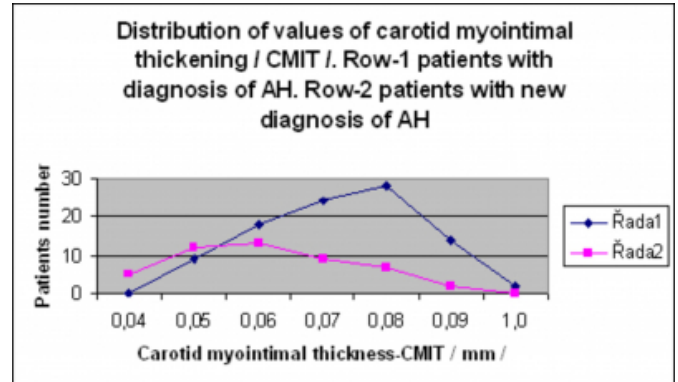
**Figure 3**

Figure 2: Distribution of the values of IVRT / isovolumic relaxation time /. There is evident shift to higher values in the group with diagnosed AH. Median for the group with defined AH is 0,1100 and for the group with new AH 0,1025. The difference is statistically not significant.



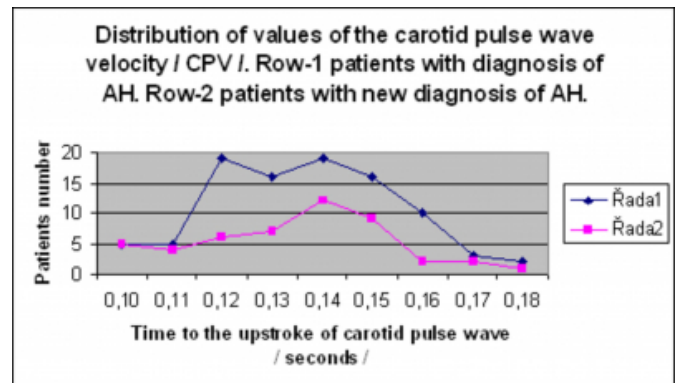
**Figure 4**

Figure 3: Distributin of the values of CMIT / carotid myointimal thickening /. There is evident shift of the values of the group with defined AH to the right to higher values. Median for the group with defined AH is 0,7000 and for the other group 0,6000. The difference between both rows is statistically significant.



**Figure 5**

Figure 4: Distribution of the values of CPV / carotid pulse velocity /. The frequency of shorter times / higher velocities / is apparently higher in the group with defined AH. But medians of both groups are identical  $\hat{A}$ – 0,1350. There is no statistical difference between both groups.



**EXERCISE STRESS TESTING**

All patients of both groups have undergone exercise stress testing on bicycle ergometer. 121 probands, i.e. 83,4% patients had hypertensive reaction on exercise / blood pressure higher than 220/120mmHg /. 84,2% of patients in the group with defined AH and 85,4% of patients in the group with new diagnosed AH had hypertensive reaction on exercise..

The course of exercise pressure reaction and the development of pressure reaction in the postexercise recovery phase is shown on the Fig. 5 and Fig.6.

Figure 6

Figure 5: BP values during exercise and recovery period in patients with chronic AH

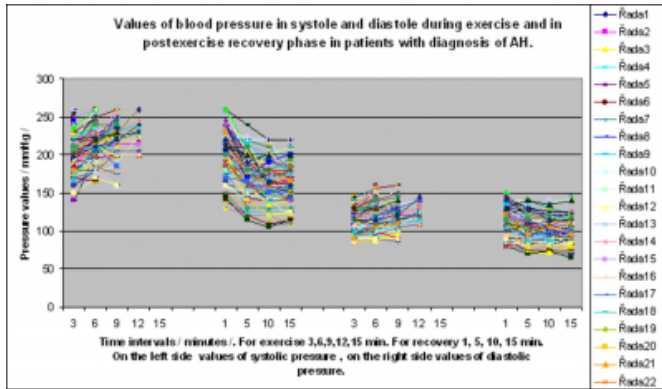


Figure 8

Table 2: Statistical comparison of BP values of single stages of exercise and recovery period As is shown there is no statistically significant difference in BP values during exercise and recovery period between both groups of patients. The measured data are practically identical.

t-tests, groups new and chronic AH : = if (v3 = 3, 1,2) (Data1)											
Variable	Aver		t	sv	p	Num.val	Num.val	S.dev	S.dev	F-ratio	p
	2	1									
3minexeS	203.9906	199.1667	1.04922	140	0.295883	106	36	24.08339	23.06822	1.089951	0.793011
6minexeS	115.2358	115.5556	-0.11614	140	0.907706	106	36	14.31586	14.13091	1.026348	0.962106
9minexeS	218.2143	212.7778	1.26751	132	0.207205	98	36	21.74418	22.72332	1.092088	0.718494
12minexeS	122.5510	122.2222	0.09657	132	0.923211	98	36	17.29437	17.94613	1.076792	0.756957
15minexeS	223.2787	222.8788	0.07864	92	0.937489	61	33	24.42480	21.75971	1.259658	0.483038
3minexeD	123.5246	124.5455	-0.26524	92	0.791419	61	33	18.71595	15.97672	1.372298	0.333429
6minexeD	229.6429	227.8125	0.24138	28	0.811022	14	16	15.12312	24.56072	2.637543	0.086581
9minexeD	127.8571	125.6250	0.40892	28	0.685709	14	16	13.40412	16.11159	1.444776	0.511295
12minexeD	240.0000	240.0000	0.00000	4	1.000000	2	4	14.14214	8.16497	3.000000	0.363390
15minexeD	135.0000	128.7500	0.52058	4	0.630147	2	4	21.21320	10.30776	4.235294	0.263501
3minrecS	204.2453	202.2222	0.39662	140	0.698621	106	36	27.65254	25.47953	1.177843	0.591757
6minrecS	113.4906	118.7500	-1.47434	140	0.142634	106	36	18.38956	19.79875	1.044997	0.837178
9minrecS	175.9962	172.7778	0.68071	140	0.509898	106	36	24.38576	24.71103	1.026855	0.887123
12minrecS	104.6887	109.3056	-1.33783	140	0.183119	106	36	18.30918	16.56816	1.221206	0.507526
15minrecS	165.8019	165.1389	0.13901	140	0.889642	106	36	24.39884	25.67617	1.107445	0.676390
3minrecD	102.8302	107.2222	-1.41156	140	0.160287	106	36	15.85678	16.92186	1.138848	0.602903
6minrecD	164.1509	160.8333	0.72036	140	0.472502	106	36	23.77946	24.15722	1.032025	0.872761
9minrecD	102.9717	102.7778	0.06026	140	0.952034	106	36	16.84351	16.18838	1.082577	0.811695

Figure 9

Table 3: Results of the t-tests. There is statistically significant difference only in CMIT .

t-tests, grouped New and chronic AH : = if (v3 = 3, 1,2) (Data1)											
Variable	Aver		t	sv	p	No.valid	No.valid	S.dev	S.dev	F-ratio	p
	2	1									
IVRT	0.110394	0.103333	1.912905	138	0.057832	104	36	0.018377	0.021044	1.311402	0.297297
CMIT	0.070604	0.062917	3.174557	140	0.001846	106	36	0.012418	0.012949	1.087386	0.725961
CPV	0.135802	0.133389	0.697342	140	0.486745	106	36	0.018233	0.017021	1.147434	0.656803

{image:9}

group No.1 – patients with chronic AH  
group No.2 – patients with new diagnosed AH

**DISCUSSION**

The statistically significant difference /p< 0.05/ between both groups was obtained in the following parameters - IVSD, IVSS, PWD, PWS, LA, E/A index, IVRT, CMIT, double product. The finding of these higher or lower values

is logical therefore in the course of time of AH there is increased incidence of myocardial hypertrophy, enlargement of left atrium, increased thickness of carotid myointima while double product and maximal heart frequency are decreasing. At present this is natural development of AH in most of patients, despite our medical treatment.

There was no statistically significant difference in the following parameters – CPV, TTP, average watts loading at the end of exercise and in the values of BP in the individual stages of exercise and recovery period /p>0.05/.

The values of CPV and TTP are identical. It could be explained, that in the group with diagnosed AH, there is reduced compliance of arterial wall / higher value of CMIT / and in consequence higher speed of blood flow. In the group with new diagnosed AH it may be due to hyperkinetic circulation.

The identical reaction and development of BP at exercise and in the recovery period in both groups of patients is rather striking. The averaged, distribution and trend curves are in both groups identical. / Fig.5, Fig.6 and Table 2 /. If we take hypertensive reaction on exercise and the abnormal course of BP in recovery period as a risk factor for development of AH then the above mentioned results confirm the usefulness of exercise stress testing in patients in early stages of AH and in ones with so called high normal BP and we should also accept the fact that to measure BP under so called basal conditions /when the patient is inactive at easy /is not sufficient to assess the disease and for decision making about antihypertensive therapy.

The exercise stress testing is advisable still from another reason. Therefore 40,6% of patients from the group with new AH had unremarkable result during ambulatory BP monitoring / maximum BP was less than 140/90mmHg /, but if these patient have undergone exercise stress testing then 85,4% of them had hypertensive reaction.

**CONCLUSION**

It is clear from the study that blood pressure reaction on exercise and in the postexercise recovery period is the diagnostic factor of greatest value from the spectrum of used measurements . If we accept the fact that hypertensive reaction on exercise stress testing is definitive risk factor for development af arterial hypertension than we have also accept the fact that blood pressure should not be measured only under so called basal conditions especially in patients with high normal blood pressure, who can have normal

blood pressure when inactive at ease, who can have even normal blood pressure on ambulatory BP monitoring. Hypertensive reaction on exercise is one of the important diagnostic moments and signs in the earliest clinical stadium of arterial hypertension at present. And if we have hypertensive reaction on stress in this group of patients than we could immediately start with antihypertensive therapy and not to recommend only changes in life style and not to wait until the patient shifts himself to the group with elevated blood pressure under basal conditions.

Stress dosing and exercise stress testing should be the part of our antihypertensive diagnostic armaments.

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