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Rare diseases of systemic circulation

Evaluation of arterial stiffness in patients with coronary atherosclerosis, cardiac syndrome X and systemic lupus erythematosus (RCD code: I-3C.1)

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Abstract

Objectives: Arterial stiffness manifested by high pulse wave velocity (PWV) consists a risk factor of atherosclerosis and cardio-vascular complications. Systemic lupus erythematosus (SLE) is a generalized autoimmune disease in which patients' prognosis depends contemporarily, in the corticosteroid era, mainly on the progression of premature atherosclerosis. The aim of the study was to assess arterial stiffness in patients with coronary atherosclerosis (CA), cardiac syndrome X (CSX) and SLE.
Materials and methods: 44 CSX patients (28 females and 16 males; mean age 55,7; arterial hypertension in 32), 44 CA patients (19 females and 25 males; mean age 61,3; arterial hypertension in 41), 29 SLE patients (25 females and 4 males; mean age 37,4; arterial hypertension in 7), 29 control group (CG) patients. PWV was measured with use of SphygmoCor in all patients.
Results: Patients with CSX had significantly lower PWV (9,63±1,69 m/s) as compared to CA patients (11,53±2,19 m/s) and significantly higher as compared to CG (8,07±1,03m/s) patients. The results of PWV in CSX and SLE patients (8,87±2,1 m/s) were similar. PWV increased with age and blood pressure in all groups. Diabetes mellitus and smoking caused PWV increase only in CA patients. Inflammatory markers didn't influence PWV among patients with CA, CSX and SLE.
Conclusions: Patients with CA have the highest arterial stiffness and significantly higher peripheral and central blood pressure. In SLE patients arterial stiffness is higher as compared to control group and similar as compared to the older CSX group. Diabetes mellitus and smoking increase arterial stiffness among CA patients. The prognostic value of PWV decrease in SLE patients should be addressed in large prospective clinical trials. JRCD 2015; 2 (2): 43–51

Key words: pulse wave velocity, autoimmune diseases, coronary disease

Objectives

Non-invasive measurement of vascular parameters are increasingly used to assess the risk of cardiovascular disease. It is considered that the loss of elasticity of arterial walls, particularly in the aorta, is a marker of early changes, which may lead to the development of atherosclerosis or any of its complications (eg. high blood pressure, stroke, myocardial infarction) [1, 2]. The measurement of the pulse wave velocity (PWV) helps in early detection of increased stiffness of the aorta wall. Standards of the European and Polish Society of Hypertension and the European Society of Cardiology [3, 4] as well as the Polish Forum for Prevention [5] point out that aortic stiffness is an independent risk factor for cardiovascular disease and that the non-invasive measurement of its rigidity have high predictive value in assessing the risk caused by these diseases.

Cardiac syndrome X (CSX) is not clearly defined disease [6, 7]. It is assumed that it is necessary to recognize the coexistence of three features: clinical symptoms of myocardial ischemia, electrocardiographic stress test changes, suggesting myocardial ischemia (reduction of ST segment in the ECG), or ischemic changes in another imaging study (eg. in the heart scintigraphy) and no obstruction observed in coronary vessels.

Despite classical risk factors of the atherosclerosis, other factors that may play role in the development of this disease include hae-

Conflict of interest: none declared.

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Table 1. Characteristics of the study groups

	group				P			
	Group 1 CSX	**Group 2 CA**	**Group 3 SLE**	**Group 4 CG**	**1vs2**	**1vs3**	**2vs3**	**3vs4**
Number of patients	n = 44	n = 44	n = 29	n = 29	–	–	–	–
sex females n(%)	28 (63,64%)	19 (43,18%)	25 (86,21%)	25 (86,21%)	NS	<0,05	<0,001	NS
males n(%)	16 (36,36%)	25 (56,82%)	4 (13,79%)	4 (13,79%)				
age (years) mean ± SD	55,7±7,9	61,3±8,9	37,4±11,7	35,2±10	0,002	<0,001	<0,000	NS
Hypertension n(%)	32 (72,73%)	41 (93,18%)	7 (28,00%)	0 (0,00%)	<0,05	<0,001	<0,001	0,002
Diabetes (%)	7 (15,91%)	10 (22,73%)	0 (0,00%)	0 (0,00%)	NS	<0,05	0,006	NS
Hypercholesterole-mia n(%)	36 (81,82%)	41 (93,18%)	3 (10,34%)	3 (10,34%)	NS	<0,001	<0,001	NS
Smoking n(%)	4 (9,1%)	14 (31,81%)	4 (13,8%)	4 (13,8%)	NS	NS	NS	NS
Positive family history n(%)	21 (47,73%)	30 (68,18%)	8 (34,78%)	6 (20,69%)	NS	NS	<0,001	NS
Obesity n(%) (BMI>30kg/m^2)	13 (29,54%)	16 (36,36%)	2 (6,89%)	1 (3,44%)	NS	<0,05	0,004	NS
WHR n(%) females ≥0,8, males ≥1,0	24 (54,54%)	19 (43,18%)	9 (31,03%)	2 (6,89%)	NS	<0,05	NS	NS

CSX- Cardiac Syndrome X, CA-atherosclerosis of the coronary arteries, SLE – systemic lupus erythematosus, CG – the control group, BMI – body mass index, WHR – waist-hip ratio

matological disorders (e.g. enlarged platelets, an increase in the activity of their aggregation) [8], estrogen deficiency [7, 8], increased sensitivity to pain [8, 9]. Also important are the endothelial dysfunction, abnormal ratio of vasoconstrictors (eg., Endothelin I) and vasodilators (eg. nitric oxide) [10] and an elevated serum concentrations of C-reactive protein [11, 12].

It has been shown that chronic systemic inflammatory process is associated with the risk of cardiovascular events. A Swedish study by Björnådal et al. [13] conducted among almost five thousand patients with systemic lupus erythematosus in the years 1964–1995 showed that the cause of 42% of deaths in this group were due to cardiovascular events and 21% of complications related to the underlying disease. It has also been shown that autoimmune connective tissue diseases lead to the coronary microvascular dysfunction [14] and the increase of arterial stiffness [15]. The pathogenesis of atherosclerosis in systemic lupus erythematosus (SLE) is multifactorial. The acceleration of atherosclerotic processes is influenced by the inflammatory activated cells and cytokines [5].

There are several non-invasive methods describing the elastic properties of vascular wall and one of the most frequently used is the pulse wave velocity (PWV). This technique has the best predictive value for cardiovascular events and simplicity of performing the measurement, is considered the gold standard for assessing arterial stiffness [2]. The European Society of Cardiology guidelines [3] on the management of arterial hypertension considered relationship ot the carotid-femoral pulse wave velocity above 12 m/s with the occurrence of organ complications of hypertension [3].

The aim of the study was to compare the stiffness of the aortic wall in the patients with coronary artery disease, cardiac syndrome X, systemic lupus erythematosis.

Population group and methodology

The study was performed in 117 patients hospitalized in the Department of Cardiac and Vascular Diseases, Institute of Cardiology, University College of Medicine Jageillońskego Specialist Hospital in Krakow. John Paul II and 29 patients from the control group.

Group 1 consisted of 44 patients diagnosed with cardiac syndrome X (CSX). Group 2 consisted of 44 patients with confirmed coronary angiographic atherosclerosis (CA). Exclusion criteria for both groups were heart failure, left ventricular ejection fraction <50%, unstable ischemic heart disease in the past six months, myocardial infarction, stenocardial symptoms in CCS class IV (Canadian Cardiovascular Society), significant valvular heart disease, use of hormone replacement therapy or oral contraceptives, irregular heart rhythm during the test, pregnancy, lack of consent to participate in the study.

Group 3 consisted of 29 patients with systemic lupus erythematosis (SLE). The diagnosis of SLE was determined according to criteria of the American College of Rheumatology. All patients were in a stable condition. The average dose glicocorticosteride was 4 mg per day. Exclusion criteria were the need for dialysis treatment, hypo- or hyperthyreoidism, liver disease the increase in value in liver transaminases (ALT or AST> 1.5 × standard), myopathies or the increase in value of phospho-creatine kinase (CPK> 5 × standard), pregnancy and lactation, exacerbation of the disease during the month preceding the qualification examination (the need to increase the dose of corticosteroids> 10 mg/d of prednisone, to join another immunosuppressive drug, hospitalization).

Group 4 (CG – control group) consisted of 29 subjects, with a sense of health, the correct result of the general phisical examination, normal blood pressure and resting ECG, the correct result of the echocardiography. This group was matched by gender and age group of 3.

Table 2. Pharmacological treatment of patients in each group

Medical treatment	group				P		
	Group 1 CSX	Group 2 CA	Group 3 SLE	Group 4 CG	1vs2	1vs3	2vs3
statins n(%)	32 (72,73%)	36 (81,82%)	– (*)	–	NS		
fibrates n(%)	2 (4,55%)	4 (9,09%)	–	–	NS		
ACEI n(%)	18 (40,91%)	27 (61,36%)	4 (13,79%)	–	0,055	0,013	<0,001
β-blockers n(%)	29 (65,91%)	35 (79,55%)	3 (10,34%)	–	NS	<0,001	<0,001
Ca-blockers n(%)	11 (25,00%)	11 (25,00%)	1 (3,45%)	–	NS	0,015	0,015
diuretics n(%)	7 (15,91%)	14 (31,82%)	3 (10,34%)	–	NS	NS	0,033
nitrates n(%)	4 (9,09%)	8 (18,18%)	–	–	NS		
ASA n(%)	33 (75,00%)	36 (81,81%)	2 (6,89%)	–	NS	<0,001	<0,001

ASA -Acetylosalicylic acid, ACE inhibitors – Angiotensin converting enzyme inhibitor, Ca-blockers – calcium channel blockers. CSX- Cardiac Syndrome X, CA-atherosclerosis of the coronary arteries, SLE Systemic lupus erythematosus, CG – the control group

The study protocol was approved by the Bioethics Committee of the Jagiellonian University No. KBET / 34 / B / 2011 of 28 April 2011.

Methodology

Despite the general examination and laboratory tests, echocardiography and the measurement of arterial stiffness were obtained.

Echocardiography was performed in all patients using a camera Toshiba Vision Power in accordance with the guidelines of the European Society of Cardiology and Polish Cardiac Society.

The evaluation of arterial stiffness was performed by non-invasive examination of the peripheral arteries. Measurements were performed on an empty stomach, before taking drugs, lying down in a quiet room, with the air temperature of 22 ±1°C. The examination was done using a camera SphygmoCor® (ATCOR Medical, Sydney, Australia) connected to a computer with software SphygmoCor Version 7.1. This camera uses a applanation tonometer with high fidelity processing (Micro-Tip pressure transducer Model SPT-301, Millar® Instruments, Houston, Texas, USA) built into the probe in the shape of a pen. PWV measurement was performed by the registration of the pulse wave graph obtained on the right common carotid artery and the right femoral artery [2]. The study was carried out independently of each other. Tonometer (Millar®) was applied first to the common carotid artery and then to the femoral artery. The measurement was performed with respect to the electrocardiograph (ECG) measured at the same time the.

Statistical analysis

Statistical analysis were performed using the statistical package STATISTICA 10 GB and MedCalc version 8.1.1.0. Continuous variables are presented as arithmetic means and standard deviations; categorical variables as numbers and percentages.

In each group, the Shapiro-Wilk test verified the existence of a normal distribution. When analyzed variables were normally distributed in both groups comparisons were performed parametric test t-Student. In case of normal distribution, although in one of the treatment groups was used for comparison non-parametric Mann-Whitney test.

When comparing more than two groups together (e.g. Ages or changes in the coronary arteries) was used for normally distributed variables in each of the treatment groups, analysis of variance. However, if even one group was not normally distributed, the variables used for analysis of variance ranks of Kruskal-Wallis. In cases where the analysis of variance indicated the existence of significant differences between the treatment groups post-hoc multiple comparison analysis was performed to examine between which groups of these differences occur.

Impact of selected variables (risk factors) on the incidence of coronary heart disease, lupus or cardiac syndrome X were tested by Chi2 independence. Pearson linear correlation was used to test the correlation between continuous variables selected.

Results

The study was conducted in a total of 146 people. Among patients at from groups 1, 2, 3 significant differences regarding age, gender, obesity, hypertension, diabetes, hypercholesterolemia and a positive family history of cardiovascular disease were shown.

According to the inclusion and exclusion criteria of the study, all patients enrolled in the study showed normal global left ventricular contractility, with preserved left ventricular ejection fraction, without significant segmental wall motion abnormalities (Table 3); no one of the patients has shown any significant valvular disease.

Table 3. Echocardiography in patients in each group

	Group 1 CSX	Group 2 CA	Group 3 SLE	Group 4 CG	P			
	n=44	n=44	n=29	n=29	1vs2	1vs3	2vs3	3vs4
LV EDD [mm]	49,8 ±6,8	48,9 ±7,0	45,6 ±4,6	44,9 ±3,9	NS	<0,05	<0,05	NS
ESD[mm]	31,7 ±5,4	31,1 ±6,6	29,8 ±3,8	27,5 ±3,3	NS	NS	NS	<0,05
IVSd [mm]	10,2 ±2,4	10,8 ±2,0	8,6 ±1,3	7,6 ±0,9	NS	=0,001	<0,001	0,001
LVPWd [mm]	9,6 ±2,3	10,2 ±1,9	8,3 ±1,1	7,7 ±1,2	NS	<0,05	<0,001	<0,05
LVEF [%]	63,0 ±5,9	63,6 ±6,9	64 ±4,1	68,5 ±3,8	NS	NS	NS	<0,001
LA [mm]	36,5 ±5,5	37,3 ±5,3	30,8 ±5,3	30 ±3,6	NS	<0,001	<0,001	NS
RVEDD [mm]	25 ±4,6	24,8 ±3,9	31,6 ±5,4	22,1 ±2,4	NS	<0,001	<0,001	<0,001

LV – left ventricle, LVEDD – left ventricular end diastolic diameter, LVESD – left ventricular end systolic diameter, EF – left ventricular ejection fraction, IVSd – intreventricular septum diastole thickness, LVPWd – left ventricular posterior wall diastole thickness, LA – left atrium, RVEDd – right ventricular end diastolic diameter, CSX- cardiac syndrome X, CA-coronary atherosclerosis, SLE – Systemic lupus erythematosus, CG – the control group

Table 4. The concentrations of lipoprotein cholesterol and triglycerides

	Group 1 CSX	Group 2 CA	Group 3 SLE	Grupa 4 CG	p			
					1vs2	1vs3	2vs3	3vs4
TChol [mmol/l]	4,79 ±1,13	4,41 ±0.85	4,76 ±1,17	4,94 ±0,97	NS	NS	NS	NS
LDL [mmol/l]	2,83 ±0,96	2,55 ±0,71	2,78 ±1,06	2,75 ±0,94	NS	NS	NS	NS
HDL [mmol/l]	1,54 ±1,48	1,43 ±0,36	1,40 ±0,31	1,76 ±0,33	NS	NS	NS	<0,001
TG [mmol/l]	1,37 ±0,72	1,33 ±0,52	1,26 ±0,49	1,18 ±0,96	NS	NS	NS	NS

TChol – Total cholesterol, LDL -Low density lipoproteins, HDL – High density lipoproteins, TG – triglicerydes, CSX- cardiac syndrome X, CA-atherosclerosis of the coronary arteries, SLE – systemic lupus erythematosus, CG – the control group

Table 5. Average values of PWV in groups

	Group 1 CSX	Group 2 CA	Group 3 SLE	Group 4 CG	P					
	n=44	n=44	n=29	n=29	1vs2	1vs3	1vs4	2vs3	2vs4	3vs4
PWV [m/s] ±SD	9,63 ±1,69	11,53 ±2,19	8,87 ±2,10	8,07 ±1,03	<0,000	NS	<0,000	<0,000	<0,000	<0,05

PWV – pulse wave velocity, CSX- Cardiac Syndrome X, CA-atherosclerosis of the coronary arteries, SLE – systemic lupus erythematosis CG – the control group

Pulse wave velocity in the group with cardiac syndrome X was significantly lower in comparison to a group of coronary atherosclerosis, but significantly higher than the values in the control group. In the contrast, pulse wave velocity results in groups with cardiac syndrome X and systemic lupus erythematosus were similar. The highest value of pulse wave velocity was observed in patients with coronary atherosclerosis and it was significantly higher compared to all other groups. It was also demonstrated that significantly higher pulse wave velocity was in the group with systemic lupus erythematosus compared to the control group.

In patients with cardiac syndrome X pulse wave velocity was greater in men than in women. In the other groups there was no significant difference addicted to sex. However, all groups showed higher pulse wave velocity in men.

There was a significant correlation of pulse wave velocity with age in all groups (for CSX patients correlation coefficient was r=0,54 767, for CA patients r=0,59 620, for SLE patients r=0,54 291 and for

Table 6. Mean values of pulse wave velocity depending on sex

group	sex	n	PWV [m/s] ± SD	p
Group 1 CSX	F	28	9,15 ±1,58	<0,01
	M	16	10,47 ±1,55	
Group 2 CA	F	19	10,83 ±1,79	NS
	M	25	12,05 ±2,35	
Group 3 SLE	F	25	8,82 ±2,21	NS
	M	4	9,19 ±1,34	
Group 4 CG	F	25	8,00 ±1,09	NS
	M	4	8,57 ±0,53	

CSX- Cardiac Syndrome X, CA-atherosclerosis of the coronary arteries, SLE – systemic lupus erythematosus, CG – the control group

the control group r=0,4537), showing an increase PWV as the population grows older.

It has been shown that in the group with cardiac syndrome X or coronary atherosclerosis age significantly contributes to the increase in pulse wave velocity.

The above statistical analysis in the group of lupus erythematosus due to the uneven distribution of age of patients was carried out in three subgroups, ie. Group 1 (<30 years), group 2 (age 31–40 years) and group 3 (> 40 years old) and showed no increase PWV. The relationship does not state the control group, which may probably be due to the young age of the patients.

In patients with coronary atherosclerosis a statistically significant effect of the presence of diabetes on the acceleration of the pulse wave velocity between patients was found. The relationship does not state for the patients with cardiac syndrome X. Patients with coronary atherosclerosis compared to patients with cardiac syndrome X were characterized by higher values of pulse wave velocity regardless of diabetes.

There was no significant statistical difference in pulse wave velocity depending on the hypercholesterolemia. This probably is the result of the fact, that patients with cardiac syndrome X and atherosclerosis of the coronary arteries had theid lipid disorders treated with suitable medications, as well as the size of the groups with or without hypercholesterolemia.

In all groups a higher average velocity of the pulse wave in patients who have smoked cigarettes was showed, but statistically significant increase of PWV was only shown in the group with coronary atherosclerosis.

All groups showed no difference in PWV values depending on the value of the body mass index BMI> 30 kg / m2. Only patients with systemic lupus erythematosus showed a higher velocity of the pulse wave according to the WHR.

Table 7A. Presents the results of the analysis carried out on the basis of multiple comparisons in order to investigate the effect of age on the pulse wave velocity. Group with cardiac syndrome X

Group	Age group		n	PWV [m/s] ± SD	ANOVA	post hoc
Group 1 Cardiac Syndrome X	2	31–40 years	2	8,34 ±2,12	p=0,007	2–5 p=0,034
	3	41–50 years	8	8,55 ±1,7		2–6 p=0,005
	4	51–60 years	23	9,45 ±1,48		3–5 p=0,043
	5	61–70 years	9	10,88 ±1,24		3–6 p=0,008
	6	>70 years	2	11,74 ±0,48		4–6 p=0,047

Table 7B. Presents the results of the analysis carried out on the basis of multiple comparisons in order to investigate the effect of age on the pulse wave velocity. Group with coronary atherosclerosis

Group	Age group		n	PWV [m/s] ± SD	ANOVA	post hoc
Group 2 Coronary atherosclerosis	2	31–40 years	0		p<0,001	
	3	41–50 years	6	9,77 ±1,92		3–5 p=0,017
	4	51–60 years	14	10,47 ±1,07		3–6 p<0,001
	5	61–70 years	17	11,86 ±1,69		4–6 p<0,001
	6	>70 years	7	14,33 ±2,49		5–6 p=0,004

Table 7C. Presents the results of the analysis carried out on the basis of multiple comparisons in order to investigate the effect of age on the pulse wave velocity. Group with systemic lupus erythematosus

Group	Age group		n	PWV [m/s] ± SD	ANOVA	post hoc
Group 3 systemie lapus erytromatosus	1	do 30 years	9	8,32 ±1,39	NS	
	2	31–40 years	8	8,25 ±1,89		
	3	41–50 years	9	9,18 ±1,28		
	4	51–60 years	2	8,54 ±0,15		
	5	61–70 years	1	13,43 ±0,00		

Table 7D. Presents the results of the analysis carried out on the basis of multiple comparisons in order to investigate the effect of age on the pulse wave velocity. The control group

Group	Age group		n	PWV [m/s] ± SD	ANOVA	post hoc
Group 4 Control group	1	do 30 years	12	7,67 ±1,02	NS	
	2	31–40 years	7	8,01 ±0,70		
	3	41–50 years	8	8,56 ±1,2		
	4	51–60 years	2	8,72 ±0,6		
	5	61–70 years	0			

Table 8. The value of pulse wave velocity (PWV) in groups depending on the presence of hypercholesterolemia

Group	Hypercholesterolemia	n	PWV [m/s] ± SD	p
Group 1 CSX	yes	36	9,61 ±1,62	NS
	no	8	9,72 ±2,10	
Group 2 CA	yes	41	11,46 ±2,10	NS
	no	3	12,49 ±3,73	
Group 3 SLE	yes	3	9,28 ±0,76	NS
	no	26	8,83 ±2,20	
Group 4 CG	yes	3	8,26 ±0,24	NS
	no	26	8,07 ±1,10	

CSX- Cardiac Syndrome X, CA- coronary atherosclerosis, SLE – systemic lupus erythematosus, CG – the control group

Discussion

The highest pulse wave velocity (11.53 ±2.19 m/s) was found in patients with coronary atherosclerosis. Mulders et al. [16] who studied 50 patients with premature coronary artery disease at the age of 46 ±3.6 and 50 first degree relatives at the age of 45.6 ±7.9 showed that the average values of PWV were respectively 9.69 ±2.9 m/s 8.15 ±1.96 m/s and were higher as compared to the control group, irrespective of other risk factors. PWV in the cited study were lower compared to the results obtained in this study. This difference was probably associated with another methodology of measuring the distance of the pulse wave – in the quoted work measured between the jugular notch and the pubic symphysis. Secondly, the reason for the higher PWV in this study is the inclusion of patients older for more than 15 years – the average age of patients in this study was 61.3 ±8.9 years.

The measurement of PWV gives also the ability to predict the severity of coronary heart disease [17]. It was shown that PWV was significantly higher in patients with coronary arteries than in patients with normal coronary arteries and that the PWV value depends on the number of affected coronary vessels. In the present study we observed similar trend, however due to small size of the group with coronary atherosclerosis it failed to show statistical significance.

The meta-analysis by Vlachopoulos et al. [18] was based on 17 studies evaluating the relationship between PWV and cardiovascular events and deaths. The authors have shown that the prognostic value of PWV is independent of the classical risk factors. They also concluded that PWV has a better ability to predict complications in patients with higher baseline cardiovascular risk (patients with coronary heart disease, hypertension, kidney disease or diabetes) than in those in the general population.

There is little data in the literature concerning the assessment of PWV in patients with cardiac syndrome X. The first study, which showed increased value of PWV in patients with cardiac syndrome

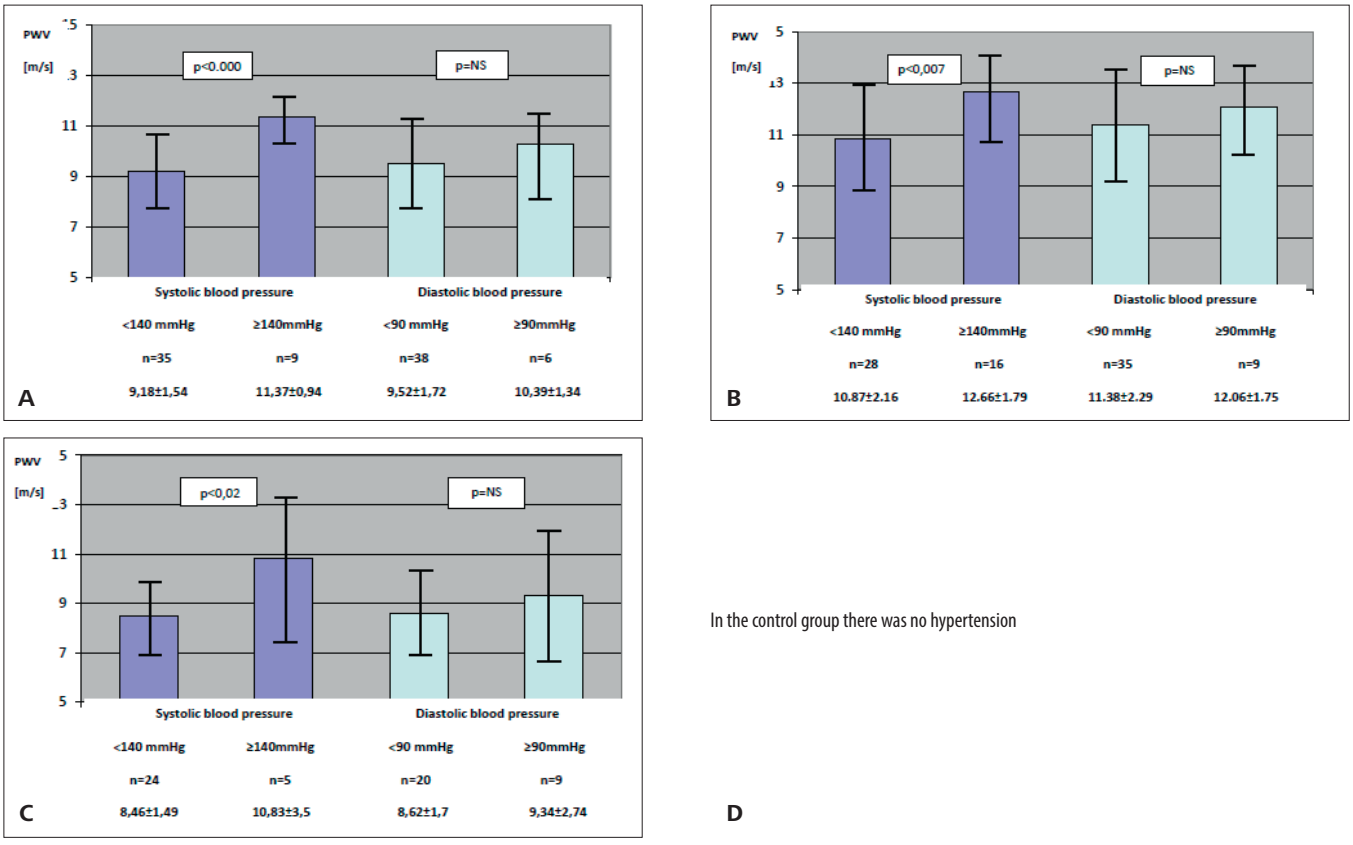

Figure 1. Dependence of the pulse wave velocity on blood pressure values. A. Group with cardiac syndrome X. B. Group with coronary atherosclerosis. C. Group with systemic lupus erythematosus. D. The control group. In the control group there was no hypertension

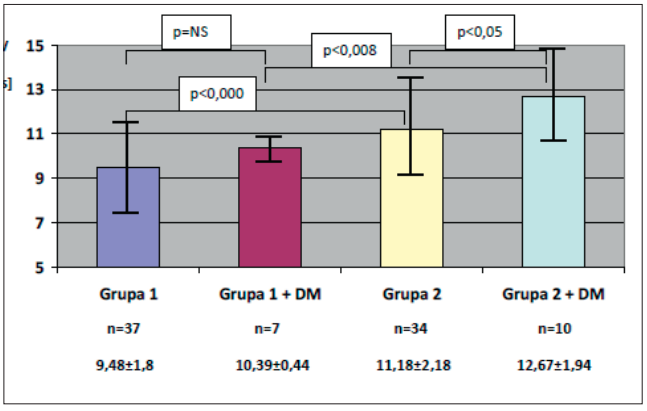

Figure 2. The pulse wave velocity in patients with cardiac syndrome X (group 1) and atherosclerosis in coronary arteries(group 2), depending on the presence of diabetes mellitus (DM)

X was done by Kidawa et al. [19]. The average value of PWV was 9.2 ±0.7 m/s. Similar PWV (9.48 ±5.0 m/s), was also obtained in the study by Mizia-Stec et al. [20]. However, it has not been found that this value was significantly higher as compared to the control group (9.08 ±5.0 m/s). In our study the mean PWV values patients in this group were 9.63 ±1.69 m / s and were significantly lower as compared to patients with coronary atherosclerosis.

In patients with systemic lupus erythematosus examined in the present study the average PWV was 8.87 ±2.1 m/s and it was significantly higher as compared to the control group matched for gender and age. The results are similar to those reported by Yildiz et al. [21] (8.98 ±2.05 m / s). Other authors found even higher values of PWV. Kockabay et al. [22] in 22 patients with newly diagnosed SLE at 35 ±2.46 years received an average PWV of 9.29 ±2.46 m / s whereas Bjarnegård et al. [23] examined 27 women with SLE aged 60 years and shown that they had higher PWV (9.8 m / s) than patients in the control group-matched for age (8.2 m / s). We obtained PWV lower by almost 1 m / s in the group with SLE what most likely arised from the younger age of the study group included in the study.

Our study showed that main risk factor influencing the value of pulse wave velocity was the height of systolic blood pressure ≥140mmHg. Among the main risk factors for cardiovascular disease the most frequent was hypertension and hypercholesterolemia and these factors involved the patients with coronary atherosclerosis and cardiac syndrome X. In addition, the patients in the group with coronary atherosclerosis were older and smokers. The results that were obtained are consistent with the POLSCREEN study [24] – the Polish national program of prevention of coronary heart disease. In the group with SLE prevalence of traditional risk factors for cardiovascular disease was significantly lower as compared to other patients. The main reason for this was most probably relatively young age of the SLE patients.

In the present study pulse wave velocity was also significantly increased with age in all patients. Mitchel et al. [25] examined PWV in population without risk factors for cardiovascular disease. The pa-

Table 9. The pulse wave velocity depending on the smoking cigarettes

Group	Smoking	n	PWV [m/s] ± SD	p
Group 1 CSX	no	40	8,97± 1,7	NS
	yes	4	9,7 ±1,55	
Group 2 CA	no	30	10,23 ±1,43	=0,006
	yes	14	12,13 ±2,24	
Group3 SLE	no	25	8,5 ±1,39	NS
	yes	4	10,47 ±4,3	
Group 4 CG	no	25	7,98 ±1,05	NS
	yes	4	8,7 ±0,88	

CSX- Cardiac Syndrome X, CA-coronary atherosclerosis, SLE – systemic lupus erythematosus, CG – the control group

Table 10a. The pulse wave velocity, depending on the Body Mass Index BMI> 30 kg / m2

Group	Obesity BMI > 30 kg/m²	n	PWV [m/s] ± SD	p
Group 1 CSX	yes	13	9,79 ±1,75	NS
	no	31	9,56 ±1,68	
Group 2 CA	yes	16	11,34 ±1,72	NS
	no	28	11,63 ±2,45	
Group 3 SLE	yes	2	8,74 ±0,17	NS
	no	27	8,88 ±2,0	
Group 4 CG	yes	1	9,3 ±0,0	NS
	no	28	8,04 ±1,03	

CSX- Cardiac Syndrome X, CA-coronary atherosclerosis, SLE – systemic lupus erythematosus, CG – the control group

Table 10b. The pulse wave velocity depending on the value WHR (≥0,8 for women, for men ≥1,0)

Group	WHR females ≥0,8 males ≥1,0)	n	PWV [m/s] ± SD	p
Group 1 CSX	yes	24	9,53 ±1,6	NS
	no	20	9,45 ±1,78	
Group 2 CA	yes	19	11,47 ±2,13	NS
	no	25	11,56 ±2,3	
Group 3 SLE	yes	9	9,37 ±0,9	0,02
	no	20	7,93 ±1,29	
Group 4 CG	yes	2	8,87 ±0,46	NS
	no	27	7,58 ±1,0	

CSX- Cardiac Syndrome X, CA-coronary atherosclerosis, SLE – systemic lupus erythematosus, CG – the control group

tients were assigned into 4 study groups according to age (<50, 50–59, 60–69,> 70). In this way, it showed a significant increase in PWV dependent on age. Interesting study by Sutton-Tyrrell K, et al. [26] showed, that in older patients (age of the study group was> 70 years old) increased PWV was strongly associated with the occurrence of cardiovascular adverse events and increased mortality.

The height of the blood pressure has a major impact on arterial stiffness [27]. In the present study the higher the blood pressure the higher pulse wave velocity and thus higher stiffness of the aorta. The increase in arterial stiffness conduct to a more rapid return of the pulse wave from the circuit which causes the increase of the blood pressure and can lead to hypertension. As the consequence, the hypertension leads to the reduction in the amount of elastic fibers, to an increase of the inextensible collagen fibers to and to disorganization in the distribution of both fibers and smooth muscle in the middle layer of the arteries' walls [28].

In the present study we found that an increase in pulse wave velocity depends on the male sex, statistical significance was only in patients with cardiac syndrome X. In turn, the acceleration of PWV in the group with coronary atherosclerosis was mainly influenced by cigarette smoking addiction and diabetes. There was no evidence that hypercholesterolemia cause the pulse wave velocity changes, but the lack of this relationship could probably arise from the fact of the treatment with use lipid-lowering drugs used in the group with cardiac syndrome X and coronary atherosclerosis. The study also showed no differences in the PWV depending on obesity, defined as a body mass index> 30 kg/m² for any of the groups, while higher PWV values were observed in patients with systemic lupus erythematosus diagnosed with abdominal obesity using the waist-to-hip ratio. However, these differences may result from a change in body composition that could be connected with usual therapy with glucocorticoids (obesity to steroid), but this finding due to the small number of studied patients requires further analysis.

There are reports that prove impact of other risk factors for atherosclerosis onthe vascular stiffening such as elevated levels of cholesterol [29], elevated blood sugar in patients with type 2 diabetes or HbA1c [30] and chronic smoking [31], and the effect of nicotine abuse if coexisting with other risk factors. On the contrary to this, is the meta-analysis by Cecelja et al. [32], which showed no significant effect of the above mentioned risk factors on the growth of PWV.

Conclusion

1. The patients with coronary atherosclerosis are characterized by higher arterial stiffness as compared to healthy subjects, patients with cardiac syndrome X and patients with systemic lupus erythematosus.
2. Pulse wave velocity in young patients with systemic lupus erythematosus is higher as compared to healthy subjects and similar to

the results obtained in elderly patients in the group with cardiac syndrome X.

3. The age of patients and blood pressure are the factors leading to increased arterial stiffness. In patients with coronary atherosclerosis additional factors affecting stiffness of the arteries are diabetes and smoking.

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