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Morphometry of peripheral arteries in the assessment of the cardiovascular risk

Parametry morfologiczne tętnic obwodowych w ocenie ryzyka sercowo-naczyniowego

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Abstract

Introduction. The aim of the study was to test the hypothesis that ultrasound measurements of common carotid artery (CCAd) and brachial artery (BAd) diameters represent markers of higher coronary artery disease risk (CAD, defined as ≥ 50% reduction in diameter of at least one large coronary artery segment).

Materials and methods. Seventy-one patients (pts) evaluated for suspected stable CAD (23.9% women, age 61.5 ± 7.5) underwent ultrasound measurements of averaged diameters of both common carotid arteries and the brachial artery diameter of dominant arm. Clinical protocol included also: standard medical examination, assessment of biochemical parameters, resting electrocardiography, treadmill exercise test and transthoracic echocardiography. Diagnosis was established using quantitative coronary angiography measurements and calculation of Gensini Score (GS).

Results. Angiographic CAD was present in 43 (60.5%) patients. Average CCAd was larger in CAD group (7.97 ± 0.96 mm vs. 7.37 ± 0.67 mm, p = 0.0052), similar to BAd (5.06 ± 0.65 vs. 4.68 ± 0.75, p = 0.03), respectively. The peripheral arterial diameters correlated with values of GS index, more pronounced for CCAd (ρ = 0.35, p = 0.0023) than for BAd (ρ = 0.24, p = 0.0368). CCAd significantly more positively correlated with the distal coronary artery segments values of the GS index (ρ = 0.35, p = 0.0024), whereas the diameter of BA with the proximal segments values of GS index (ρ = 0.239, p = 0.045). CCA and BD diameters indexed to body surface area (BSA) showed a strong trend toward larger average diameters in CAD patients: CCAd/BSA index: 4.06 ± 0.46 mm/m^2 vs. 3.85 ± 0.56 mm/m^2, p = 0.087, BAd/BSA index: 2.57 ± 0.29 mm/m^2 vs. 2.42 ± 0.35 mm/m^2, p = 0.057. Gensini score significantly correlated with CCAd/BSA index (ρ = 0.24, p = 0.043) with a strong trend of positive correlation between GS index and BAd/BSA index (ρ = 0.21, p = 0.076).

Conclusions. The diameters of common carotid arteries and the brachial artery of dominant arm are greater in CAD pts. Peripheral arteries ultrasound may complement classic diagnostic pathway of stable coronary artery disease.

Key words: coronary artery disease, peripheral arteries ultrasound

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Introduction

Coronary disease is a manifestation of atherosclerotic process which can be present in multiple arterial beds. Therefore imaging of peripheral arteries with ultrasound may complement the understanding of advanced atherosclerotic disease.

Detection of endothelial dysfunction and evaluation of atherosclerotic lesions in peripheral arteries is a useful marker of arterial disease severity and extent.

Non-invasive methods based on ultrasonography the most commonly used techniques for assessing peripheral arterial walls include: assessment of the thickness of the intima media (IMT, intima–media thickness) and evaluation of the flow-dependent expansion of the brachial artery (FMD, flow-mediated dilatation) [1, 2]. Some studies indicated the importance of ultrasound measurement of peripheral arterial diameter at rest, without further evaluation of their vasodilatory reactivity. This concept is based on the theory of vascular remodeling, which is a consequence of exposure to adverse factors leading to damage to the wall of the arteries. The result of this process is a gradual increase in arteries diameters, including both coronary and peripheral circulation. Thanks to advances in the development of high resolution ultrasonography, it has become possible to evaluate vascular remodeling within periphery arteries in vivo, usually using to measure the brachial artery and carotid arteries, which lie superficially and are easy to evaluate by ultrasound [3–5].

The aim of the present study was to evaluate the measurements of brachial artery diameter of dominant arm and both common carotid arteries diameters as markers correlated with the presence of coronary disease.

Material and methods

The study group consisted of 54 men (76.1%) and 17 women (23.9%), average age of 61.5 ± 7.5 years, without symptomatic atherosclerosis of carotid or extremity arteries referred to the tertiary cardiology center for the diagnostics of coronary artery disease. Prior to inclusion, each participant signed informed consent to participate in the study. The study protocol was approved by the Bioethics Committee of the Medical University of Lodz.

The studied group was divided into two subgroups: patients with angiographic confirmation of significant angiographic coronary stenoses [coronary artery disease group (+) — CAD (+)] and a group of patients, without the presence of significant stenoses in the coronary arteries [coronary artery disease group (–) — CAD (–)], defined as ≥ 50% diameter reduction of at least one segment of the large coronary artery (LMCA, LAD, LCx, RCA) or one of their larger primary branches. Based on the results of the coronarography presence of significant stenoses within the coronary arteries was found in 43 (60.6%) patients. Demographic data, prevalence of specific risk factors for coronary artery disease, and coronary angiography details are presented in Table 1.

Table 1. Patients characteristics

Parameter	Mean	Range
Age	61.5 ± 7.5	54–70
Men	54	76.1%
Body mass	81.3 ± 13.7	70.2–90.0
Body mass index [kg/m^2]	27.8 ± 3.6	24.9–31.0
Obesity	22	31%
Smoking	23	32.4%
Diabetes mellitus	20	28.2%
Hypertension	61	85.9%
Chronic kidney disease	3	4.2%
Peripheral artery disease	9	12.7%
Myocardial infarction in past	12	16.9%
1-vessel disease	21	30%
2-vessel disease	11	15.5%
3-vessel disease	11	15.5%
Gensini Score index	27 ± 31.2	0–52.6

The study protocol included clinical examination, resting electrocardiography (ECG), assessment of biochemical markers, transthoracic echocardiography, ECG stress test according to Bruce protocol, and ultrasound measurements of averaged diameters of both common carotid arteries (CCAd) and the brachial artery diameter (BAd) of dominant arm.

Ultrasound measurement of peripheral vascular diameters: common carotid arteries and brachial artery of dominant arm

The bilateral ultrasound examination of common carotid arteries and the brachial artery of dominant arm was made in a B-mode presentation, using ultrasound Logiq400 Pro GE (General Electric) and ultrasound Sonoace PICO (Medison Sonoace), with a linear probe 7.5–9 MHz. The diameter of the vessel was evaluated in end diastolic phase by measuring the distance between the proximal and distal "M" line, which is a boundary between the intima media and the adventitia [6, 7]. All examinations were performed by one ultrasonographer.

During measuring of the common carotid arteries diameters, the subjects were in a supine position with a head arranged in a deviation of approximately 45° with respect to the sagittal plane of the body and in the opposite direction to the examined vessel. Visualization of vessels was performed in their longitudinal projection. The study was performed at approximately 10 mm proximal to the

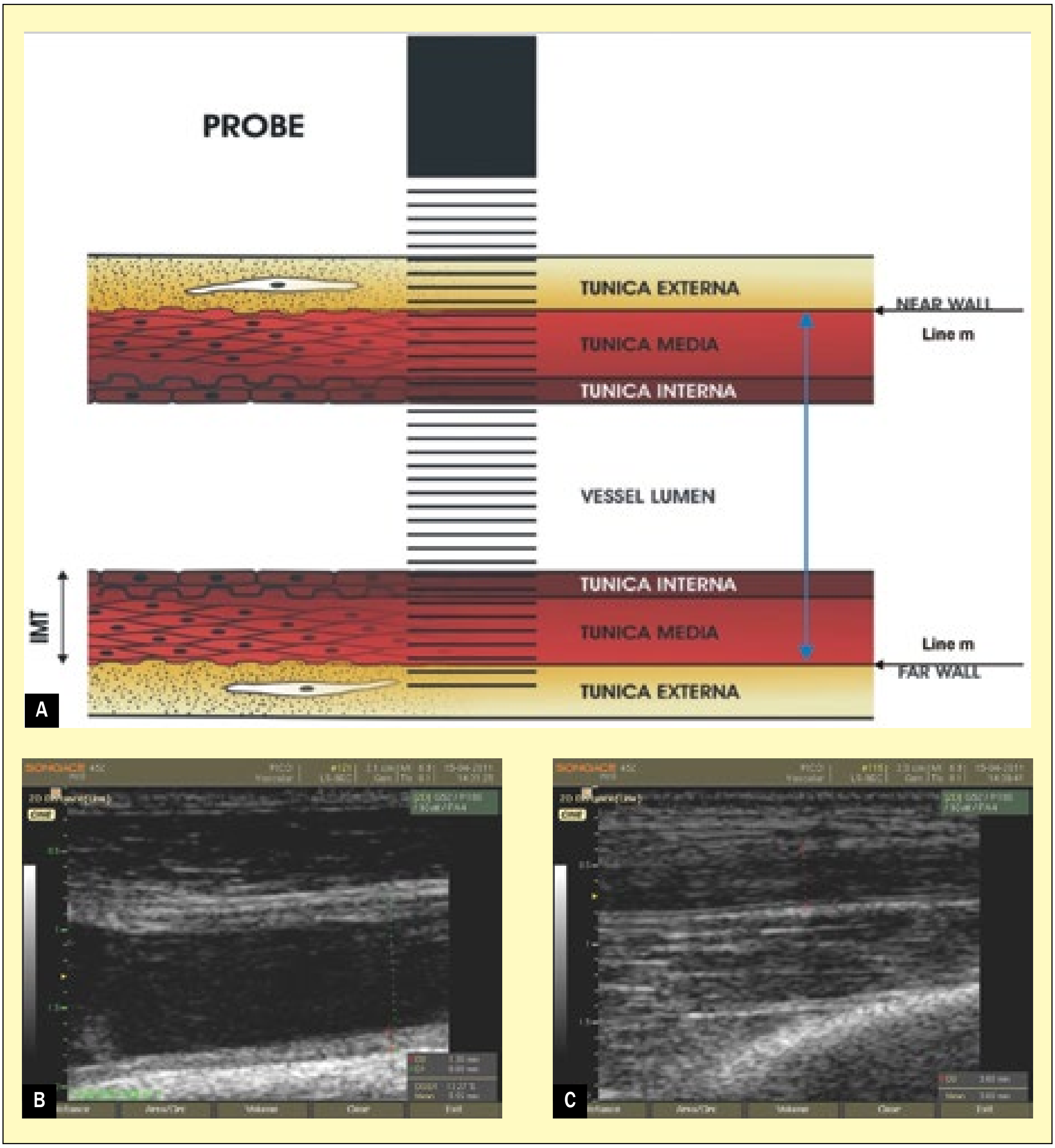

Figure 1A–C. The principle of measuring the diameter of examined peripheral arteries and sample measurements of common carotid artery diameter and measurement of brachial artery diameter

carotid bulb. With regard to the evaluation of brachial artery diameter of dominant arm measurement was taken at 5–10 cm above the bottom of the elbow. The diameter of the examined vessel was determined by averaging 5 heart cycles — Figure 1.

Coronarography

The study was performed in the Hemodynamics Laboratory of the Chair and Department of Cardiology of the Medical University of Lodz on the Innova 2000 angiography (GE Health Care) from radial or femoral access by the Seldinger method. The degree of coronary artery stenosis was assessed visually using quantitative analysis in doubtful cases. Semi-quantitative analysis of atherosclerotic lesions was performed, using Gensini Score, which is the sum of the points assigned to the individual coronary arteries associated with particular segments of the coronary arteries depending on the location of the degree of lumen reduction.

Vascular segments were divided into proximal (proximal Gensini Score) including respectively — LM, p-LAD, LCx-p, p-RCA and distal sections (distal Gensini Score) [8].

Statistical analysis

All quantitative variables were pre-tested for compatibility with the normal distribution in Kolmogorov-Smirnov test. In the presentation of quantitative variables in the case where the variable had normal distribution, the values were expressed as mean ± standard deviation (M ± SD).

In the case of rejecting the normal distribution hypothesis, the median and the interquartile range were used to characterize the variable. Qualitative variables were presented as numbers (n) and percentage participants in the study group. For the comparison of the test and control groups in the situation of positive verification of the hypothesis of normal distribution, the *t*-Student test was used. For more variables, ANOVA variance analysis was used. For non-normal distributions, the Mann-Whitney U test for two variables or the Kruskal-Wallis test for more variables was used.

To assess the strength of relationship between the variables in the study population, the linear correlation coefficients were calculated. For variables with a parametric distribution was used Pearson correlation coefficient (r); for nonparametrically distributed variables — Spearman's rank correlation coefficient (ρ). In order to determine the optimal values of the investigated parameters which might indicate the presence of significant myocardial ischemia, an analysis was performed using ROC (receiver operating curve).

In statistical analysis licensed copy of a computer program MedCalc® (MedCalc Software, Frank Schoonjans 1993-2012, Belgium) version 12.2.1 was used.

Results

Ultrasound characteristics of peripheral arteries, and demographic data

Examined ultrasonographic parameters differed significantly between the genders — in the group of female the mean brachial artery diameter was 4.20 ± 0.66 mm and in the male group it was 5.10 ± 0.59 mm, $p < 0.0001$. The mean value of common carotid arteries on the right side in the female group was 7.42 ± 0.80 mm, and in men it was 7.88 ± 1.0 mm, $p = 0.093$; on the left side it was 7.31 ± 81 mm and 7.83 ± 0.91 mm, respectively, $p = 0.039$; and after averaging the values on both sides, in the female group it was 7.36 ± 0.74 mm, and in men 7.85 ± 0.92 mm, $p = 0.046$.

Analysis of subsequently collected ultrasound data showed that peripheral arterial diameters were different between smokers and non-smokers. The mean value of common carotid arteries diameters in non-smokers was 7.54 ± 0.70 mm and in smokers 8.14 ± 0.84 mm, $p = 0.007$, and brachial diameters were 4.78 ± 0.72 mm and 5.18 ± 0.61 mm, respectively, $p = 0.027$.

Correlation analysis of examined ultrasonographic parameters with body surface index (BSA) showed their association, especially with regard to brachial artery diameter ($r = 0.52$, $p < 0.0001$). Similar correlations were observed in the analysis of patients' growth. These differences may explain the dissimilarities observed between male and female patients. The collected data are presented in Table 2.

In the analysis of ultrasonographic parameters indexed to the body surface area, a significantly greater carotid artery diameter was found in women compared to men ($p = 0.02$), which was not observed with respect to the brachial artery — Table 3.

Measurement of peripheral arterial diameters, and the results of echocardiography

Carotid and brachial artery dimensions correlated with echocardiographic parameters — Table 4. The left atrial size correlated with the diameter of common carotid artery and brachial artery ($r = 0.26$, $p = 0.028$, $r = 0.42$, $p = 0.0002$). The thickness of the end-systolic interventricular septum correlated with the diameter of the brachial artery ($r = 0.24$, $p = 0.04$). The thickness of the end-diastolic interventricular septum correlated with the diameter of the common carotid artery and the brachial artery ($\rho = 0.24$, $p = 0.04$, $\rho = 0.3$, $p = 0.009$). The thickness of the posterior myocardial wall correlated with brachial artery diameter ($\rho = 0.33$, $p = 0.004$). The thickness of the end-diastolic posterior wall, correlated both with common carotid arteries ($\rho = 0.27$, $p = 0.02$) and brachial artery diameter ($\rho = 0.31$, $p = 0.008$). A parameter strongly associated with the larger arterial diameters was also the left ventricular myocardial mass.

The dimensions of the arteries and the results of coronary angiography

Analysis of collected data from coronary angiography and peripheral vascular ultrasonography revealed that the diameters of the peripheral arteries examined in groups with confirmed or absent angiographic CAD differed significantly. On average, the diameter of the common carotid artery was 7.97 ± 0.96 mm in patients with significant angiographic lesions and 7.37 ± 0.67 mm in the group without coronary artery disease, $p = 0.005$. Brachial artery diameters were 5.06 ± 0.65 mm and 4.68 ± 0.75 mm, respectively, $p = 0.03$. A strong trend for larger diameters of the arteries in patients with coronary artery disease remained after BSA indexation — Table 5.

Table 6 and Figure 2 show descriptive analysis of the examined ultrasonographic parameters in subgroups of patients differing in the number of narrowed major epicardial coronary arteries. Unindexed diameters of common carotid arteries in patients with one-vessel disease and three-vessel disease were significantly larger than in those without CAD.

Table 2. Analysis of the relationship between ultrasound parameters and demographic data

Variable	Mean ØCCA [mm]	Mean ØCCA [mm]/BSA	ØBA [mm]	ØBA [mm]/BSA
CCS class	ρ = 0.188	**ρ = 0.23**	ρ = 0.06	ρ = 0.12
	p = 0.11	**p = 0.047**	p = 0.58	p = 0.29
NYHA class	**ρ = 0.297**	ρ = 0.14	ρ = 0.05	ρ = –0.05
	p = 0.011	p = 0.23	p = 0.67	p = 0.68
Age	r = 0.2	**r = 0.37**	r = –0.13	r = 0.02
	p = 0.08	**p = 0.001**	p = 0.25	p = 0.85
Diabetes mellitus	p = 0.09*	p = 0.14*	p = 0.3*	p = 0.26*
Hypertension	p = 0.72*	p = 0.49*	p = 0.91*	p = 0.68*
Smoking	**p = 0.007***	**p = 0.047***	**p = 0.0268***	**p = 0.039***
Peripheral artery disease	p = 0.61*	p = 0.86*	p = 0.33*	p = 0.54*
BMI [kg/m²]	r = 0.19	**r = –0.31**	r = 0.18	**r = –0.28**
	p = 0.1	**p = 0.006**	p = 0.12	**p = 0.01**
BSA [m²]	**r = 0.29**	–	**r = 0.52**	–
	p = 0.01		**p < 0.0001**	
Height [cm]	**r = 0.257**	**r = –0.34**	**r = 0.49**	r = –0.003
	p = 0.03	**p = 0.003**	**p < 0.0001**	p = 0.98
Sex	**p = 0.046***		**p < 0.0001***	

In the table are compiled the Pearson r correlation coefficients and the Spearman correlation coefficients. The value of "p" calculated using the t test for independent samples*; p — level of statistical significance; ØCCA mean — arithmetic mean of carotid artery diameter; ØBA — diameter of the brachial artery of dominant arm; CCS — Canadian Cardiovascular Society; NYHA — New York Heart Association; BMI — body mass index; BSA — body surface area

Table 3. Analysis of the index values — the diameter of brachial artery diameter and common carotid arteries to body surface area (BSA) according to gender

Parameter	Men n = 54	Female n = 17	p
ØRCCA/BSA	3.91 ± 0.55	4.26 ± 0.51	**0.026**
ØLCCA/BSA	3.89 ± 0.49	4.19 ± 0.46	**0.03**
Mean ØCCA/BSA	3.9 ± 0.51	4.2 ± 0.44	**0.02**
Mean ØBA/BSA	2.54 ± 0.31	2.42 ± 0.35	0.19

The value of "p" calculated using the t-test for independent samples; p — level of statistical significance; ØCCA mean — arithmetic mean of carotid artery diameter; ØBA — diameter of the brachial artery of dominant arm; BSA — body surface index

Arterial diameters were correlated with Gensini Score more significantly for the common carotid artery (ρ = 0.35, p = 0.0023) than the brachial artery (ρ = 0.24, p = 0.0368). The mean diameter of common carotid arteries significantly correlated with the Gensini Score index of the distal coronary arteries segments (ρ = 0.35, p = 0.0024), while the brachial artery diameter with the Gensini Score index of the proximal segments (ρ = 0.239, p = 0.045). After indexation to BSA, only dimension of common arteries significantly correlated with the values of Gensini Score index — Table 7 and Figure 3.

The presence of angiographically significant CAD was predicted by common carotid artery diameter > 7.6 mm with a sensitivity of 62.8% and a specificity of 75.0% (area under ROC curve — 0.697; 95% CI: 0.577–0.801), positive and negative predictive values were 79.4% and 56.7% respectively, and accuracy was 67.6%. Analysis of the ROC curve for brachial artery diameter > 4.9 mm showed a prognostic value for the presence of significant coronary stenoses with a sensitivity of 69.8% and a specificity of 60.7% (area under ROC curve — 0.653, 95% CI: 0.53–0.762), positive and negative predictive values were 73.2% and 56.7%, respectively, accuracy of 66.2%.

Table 4. Correlation analysis of selected parameters of echocardiography with peripheral vascular ultrasonography

Variables	Mean ØCCA [mm]	Mean ØCCA [mm]/BSA	ØBA [mm]	Mean ØBA [mm]/BSA
LV systolic diameter [mm]	r = –0.13	r = –0.11	r = –0.02	r = –0.06
	p = 0.28	p = 0.35	p = 0.88	p = 0.58
LV diastolic diameter [mm]	r = 0.17	r = 0.7	r = 0.19	r = –0.025
	p = 0.16	p = 0.54	p = 0.11	p = 0.83
Left atrium diameter [mm]	**r = 0.26**	**r = –0.24**	**r = 0.43**	r = 0.02
	p = 0.028	**p = 0.04**	**p = 0.0002**	p = 0.84
Aortic diameter [mm]	r = –0.006	**r = –0.25**	r = 0.2	r = –0.03
	p = 0.95	**p = 0.03**	p = 0.09	p = 0.80
Right ventricular diameter [mm]	r = –0.08	**r = –0.25**	r = 0.04	r = –0.12
	p = 0.5	**p = 0.029**	p = 0.7	p = 0.29
Septal thickness systolic diameter [mm]	r = 0.14	r = –0.0002	**r = 0.24**	r = 0.09
	p = 0.24	p = 0.99	**p = 0.04**	p = 0.43
Septal thickness diastolic diameter [mm]	**ρ = 0.24**	r = –0.038	**ρ = 0.3**	r = 0.04
	p = 0.04	p = 0.75	**p = 0.009**	p = 0.7
Posterior wall thickness systolic diameter [mm]	ρ = 0.12	r = 0.1	**ρ = 0.33**	r = 0.18
	p = 0.3	p = 0.4	**p = 0.004**	p = 0.11
Posterior wall thickness diastolic diameter [mm]	**ρ = 0.27**	r = –0.027	**ρ = 0.31**	r = 0.19
	p = 0.02	p = 0.82	**p = 0.008**	p = 0.1
Ejection fraction [%]	r = –0.1	r =–0.17	r = –0.16	**r = –0.27**
	p = 0.37	p = 0.16	p = 0.16	**p = 0.02**
LV mass [g]	r = 0.32	r =–0.01	**r = 0.3**	r = 0.05
	p = 0.057	ρ = 0.92	**p = 0.009**	ρ = 0.67
LV mass index [g/m^2]	r = 0.13	r = 0.06	r = 0.18	r = 0.14
	p = 0.27	p = 0.62	p = 0.12	p = 0.23

The table summarizes the Pearson r correlation coefficients and the Spearman correlation coefficients. p — level of statistical significance; LV — left ventricle

Table 5. Analysis of brachial artery diameter and carotid artery diameter

Parameter	CAD (+) n = 43	CAD (–) n = 28	p
ØRCCA [mm]	8.05 ± 0.99	7.33 ± 0.75	**0.002**
ØRCCA/BSA	4.1 ± 0.5	3.83 ± 0.61	**0.049**
ØLCCA [mm]	7.9 ± 0.98	7.42 ± 0.70	**0.03**
ØLCCA/BSA	4.02 ± 0.45	3.87 ± 0.55	0.21
Mean ØCCA [mm]	7.97 ± 0.96	7.37 ± 0.67	**0.005**
Mean ØCCA/BSA	4.06 ± 0.46	3.85 ± 0.56	0.087
ØBA [mm]	5.06 ± 0.65	4.68 ± 0.75	**0.03**
ØBA/BSA	2.57 ± 0.29	2.42 ± 0.35	0.057

ØRCCA — diameter of the right common carotid artery; ØLCCA — diameter of the left common carotid artery; ØCCA mean-arithmetic mean of carotid arteries diameters; ØBA — diameter of the brachial artery of dominant arm; BSA — body surface area; CAD (+) — group with coronary artery disease; CAD (–) — group without coronary artery disease

Table 6. Results of measurements of brachial arterial diameter and carotid arteries diameters before and after indexing to the body surface area according to the number of significant stenoses in the main epicardial arteries

Parameter	Without CAD n = 28	1-vessel disease n = 21	2-vessel disease n = 11	3-vessel disease n = 11	p
ØRCCA [mm]	7.33 ± 0.75	8.02 ± 1.05	7.65 ± 0.88	8.5 ± 0.89	**0.002**
ØLCCA [mm]	7.42 ± 0.70	7.9 ± 1.0	7.48 ± 0.66	8.3 ± 1.1	**0.025**
Mean ØCCC [mm]	7.37 ± 0.67	7.96 ± 0.99	7.57 ± 0.75	8.4 ± 0.97	**0.005**
ØBA [mm]	4.68 ± 0.75	4.96 ± 0.6	5.1 ± 0.59	5.2 ± 0.81	0.139
ØRCCA/BSA	3.83 ± 0.61	4.13 ± 55	3.92 ± 0.47	4.24 ± 0.41	0.12
ØLCCA/BSA	3.87 ± 0.55	4.0 ± 0.5	3.83 ± 0.39	4.12 ± 0.4	0.29
Mean ØCCA/BSA	3.85 ± 0.56	4.1 ± 0.51	3.88 ± 0.42	4.18 ± 0.37	0.19
ØBA/BSA	2.42 ± 0.35	2.55 ± 0.28	2.6 ± 0.29	2.58 ± 0.32	0.28

The "p" value calculated using the ANOVA variance test; p — level of statistical significance; ØRCCA — diameter of the right common carotid artery; ØLCCA — diameter of the left common carotid artery; ØCCA mean — arithmetic mean of carotid arteries diameters; ØBA — diameter of the brachial artery of dominant arm

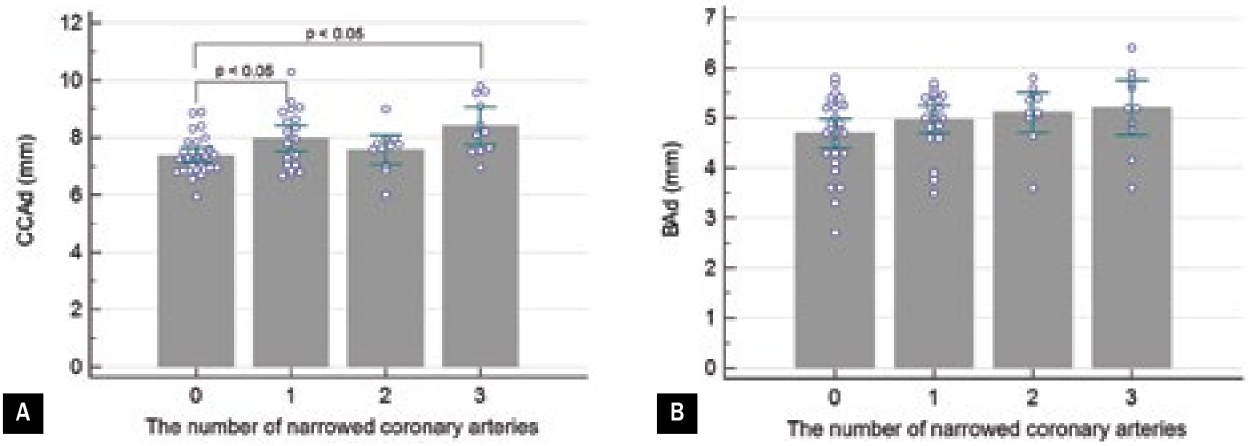

Figure 2. Comparison of the average diameters of common carotid arteries (CCA; **A**) and the brachial artery diameter (BA; **B**) depending on the number of coronary arteries with angiographically significant stenoses

Discussion

The results of the present study indicate that remodeling and dilatation of large arteries may be related to coronary atherosclerotic process.

Initial prospective experimental studies assessing the diameters of the peripheral arteries were conducted on animal models in which an inadequate increase in the diameters of arteries in response to an atherogenic diet rich in saturated fatty acids was observed. One of the first researchers who described this relationship in humans were Glagov and Zarins, evaluating autopsy correlations between arterial diameter and degree of atherosclerotic lesions within coronary arteries [9, 10]. Vascular remodeling has been demonstrated as a compensatory arterial response to progression of atherosclerosis to maintain adequate vascular flow. Further experiments have shown that progression and maintenance of this process is possible to a certain level, after which it comes to the predominance of "vasoconstrictive" atherosclerotic plaques, which may result in both gradual vasoconstriction and sudden rupture of existing atherosclerotic plaques.

It has been proven that both too small and excessive shear forces acting on the vessel wall contribute to abnormal cellular reaction of the intima, resulting in their hypertrophy and pathological vascular remodeling.

The results of the studies demonstrate the interdependence of observed vascular changes, with risk factors for atherosclerosis [11–13]. Previous publications suggested the predictive value of measurements of resting brachial artery diameter is similar to flow-mediated dilation (FMD) examination with regard to the risk of coronary disease. Importantly, measuring arterial diameter is easier and less time consuming. It was confirmed by work published by Yeboah at al. [14]. It has been demonstrated that, after taking into account additional risk factors such as gender, age, type 2 diabetes, hypertension, nicotine addiction, larger brachial artery diameter positively correlated with

Table 7. Analysis of the correlation between the values of the diameters of the examined arteries, and values of the Gensini Score index

Variable	Gensini Score	Proximal Gensini Score	Distal Gensini Score
ØRCCA [mm]	**ρ = 0.4**	ρ = 0.24	**ρ = 0.38**
	p = 0.0006	**p = 0.04**	**p = 0.0009**
ØLCCA [mm]	**ρ = 0.26**	ρ = 0.11	**ρ = 0.29**
	p = 0.025	p = 0.33	**p = 0.013**
Mean ØCCA [mm]	**ρ = 0.35**	ρ = 0.2	**ρ = 0.35**
	p = 0.0023	p = 0.082	**p = 0.0024**
ØBA [mm]	**ρ = 0.24**	**ρ = 0.239**	ρ = 0.18
	p = 0.0368	**p = 0.045**	p = 0.118
Mean ØCCA/BSA	**ρ = 0.24**	ρ = 0.13	ρ = 0.2
	p = 0.043	p= 0.27	p= 0.09
ØBA/BSA	ρ = 0.21	ρ = 0.19	ρ = 0.12
	p = 0.076	p = 0.09	p = 0.29

ØRCCA — diameter of the right common carotid artery; ØLCCA — diameter of the left common carotid artery; ØCCA mean — arithmetic mean diameter of the carotid arteries; ØBA — diameter of the brachial artery of dominant arm

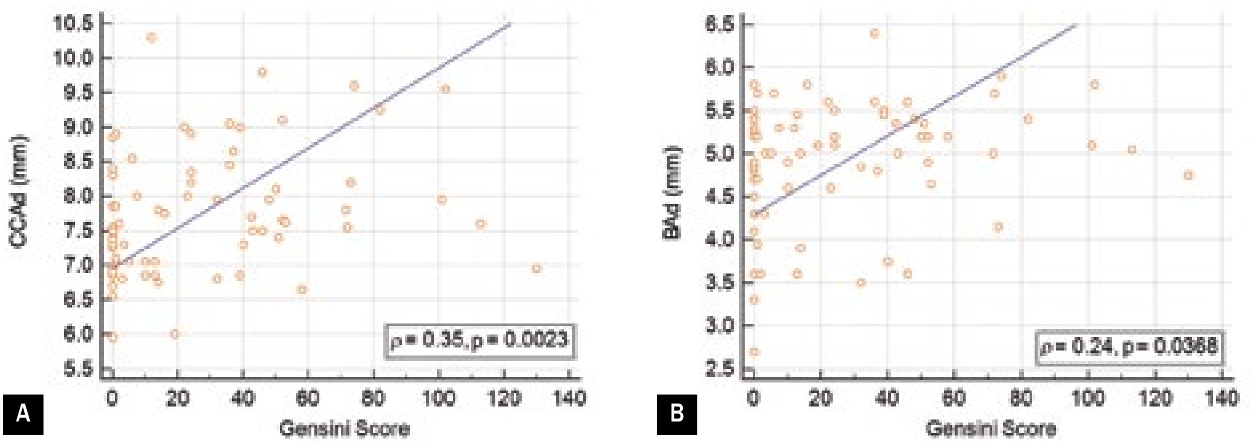

Figure 3A, B. Correlations of carotid artery diameters and brachial artery diameter with Gensini Score index

cardiovascular events. The median diameter of this vessel at rest was 5.1 mm for men and 4.06 mm for women. With an increase in diameter of the brachial artery above 1 mm in average, the risk of cardiovascular events increased by approximately 1.12 times (1.02 to 1.28) [14].

Another study that demonstrated diagnostic usefulness of the assessment of brachial artery diameter at rest was work carried out by Holubkov et al. [15]. This study conducted on a group of 376 women confirmed that the increase in artery diameter at rest positively correlated with the degree of coronary atherosclerosis assessed in coronarography. After adjusting for age, body weight and other risk factors of coronary artery disease, it was demonstrated that the probability of significant atherosclerotic lesions in the coronary arteries (> 50% stenosis in ≥ 1 vessels) was approximately 3.6 times greater in women with brachial artery diameter greater than 4.1 mm than in women with brachial artery diameter at rest below 3.6 mm [15]. In another study, Montalcini et al. [16] evaluated correlations of IMT values and the presence of atherosclerotic plaques in carotid arteries with resting brachial artery diameters in diastole. The study was conducted on 166 postmenopausal women. The presence of significant atherosclerotic lesions in carotid arteries was associated with a significantly larger diameter of both of these vessels as well as the brachial artery. The mean diameter in the control group was 6.86 mm and 6.75 mm for the right and left carotid artery and in the group with the presence of significant atherosclerosis it was 7.3 mm and 7.06 mm, respectively. For brachial arteries these values were 3.57 mm and 3.82 mm, respectively [16]. A similar correlation was observed in the analysis by Steinke et al. which also demonstrated a significant correlation between the presence of atherosclerotic plaques and carotid artery enlargement [4]. Additionally, some data suggest prognostic implications of larger arterial diameter.

Our study reproduces these finding in the Polish population. Among the analyzed echocardiographic data, larger diameters of examined peripheral arteries correlated also with left ventricular mass and left atrial size. The association between the thickness of the ventricular septum and the posterior wall of the left ventricle with larger diameters of the arteries was also present.

Regarding the average values of the diameters of common carotid arteries and the brachial artery in patients with significant coronary atherosclerotic lesions, they were significantly higher; however, after indexing of the examined parameters to body surface area, the relationships decreased to the trend level. Similar significant correlations were observed after the use of semi-quantitative analysis of atherosclerotic lesions in coronary arteries expressed as Gensini Score index. After indexation by BSA, significant correlation was found only with respect to the common carotid artery — ρ = 0.24, p = 0.043. These results correspond to the results reported by Mirek where larger carotid arteries and femoral artery were observed with more advanced coronary atherosclerotic lesions assessed both quantitatively and with Gensini Score index [17].

The abovementioned publications and observations based on ongoing analysis indicate that the diameter of the examined vessel also should be taken into account in the ultrasound assessment of peripheral vascular morphology. Ultrasonographic evaluation of peripheral vascular morphology can, indirectly, also provide information of coronary artery status, allowing, in combination with classical coronary artery disease risk factors and the results of other studies, improved classification of patients for more advanced diagnostics methods and consequently proper treatment.

Conclusions

The results of the current study confirm that ultrasound assessment of peripheral arterial diameter may contribute to atherosclerotic risk assessment. Optimal presentation of these parameters including indexation is subject to future research.

Conflict of interest

The authors declare that there is no conflict of interest

Streszczenie

Wstęp. Celem badania była weryfikacja hipotezy, czy ultrasonograficzny pomiar średnic tętnic szyjnych wspólnych (CCAd) i tętnicy ramiennej (BAd) może stanowić marker zwiększonego ryzyka wystąpienia choroby wieńcowej (CAD), definiowanej jako zwężenie większe lub równe 50% średnicy co najmniej jednego segmentu dużej tętnicy wieńcowej.

Materiały i metody. Diagnozowanych w kierunku choroby wieńcowej 71 pacjentów (23,9% kobiet, średni wiek 61,5 ± 7,5) poddano ultrasonograficznej ocenie średnic obu tętnic szyjnych wspólnych i tętnicy ramiennej dominującej kończyny górnej. Protokół badania obejmował również ocenę kliniczną, ocenę wskaźników biochemicznych, spoczynkowy zapis elektrokardiograficzny, elektrokardiograficzny test wysiłkowy, przezklatkowe badanie echokardiograficzne, z weryfikacją wyników w koronarografii i oceną zmian w naczyniach wieńcowych metodą cyfrowej angiografii ilościowej i wyliczeniem wskaźnika Gensiniego (GS).

Wyniki. Obecność istotnych zwężeń w koronarografii stwierdzono u 43 (60,5%) pacjentów. Średnia wartość CCAd była większa u pacjentów z CAD (7,97 ± 0,96 mm *vs.* 7,37 ± 0,67 mm; p = 0,0052), podobnie jak wartość BAd (5,06 ± 0,65 *vs.* 4,68 ± 0,75; p = 0,03). Wartości średnic tętnic obwodowych korelowały ze wskaźnikiem GS bardziej wyraźnie w przypadku CCAd (ρ = 0,35; p = 0,0023) niż dla BAd (ρ = 0,24; p = 0,0368). Wartości CCAd znacząco wyraźniej dodatnio korelowały z dystalnymi segmentami (ρ = 0,35; p = 0,0024), natomiast średnica BA — z proksymalnymi segmentami tętnic wieńcowych ocenianych według GS (ρ = 0,239; p = 0,045). Po zastosowaniu metody indeksacji do pola powierzchni ciała (BSA) stwierdzono obecność silnego trendu w kierunku wyższych wartości średnic badanych tętnic obwodowych wśród pacjentów z chorobą wieńcową — wskaźnik CCAd/BSA: 4,06 ± 0,46 mm/m^2 *vs.* 3,85 ± 0,56 mm/m^2, p = 0,087, wskaźnik BAd/BSA: 2,57 ± 0,29 mm/m^2 *vs.* 2,42 ± 0,35 mm/m^2, p = 0,057. Wskaźnik Gensiniego znacząco korelował z indeksem CCAd/BSA (ρ = 0,24; p = 0,043) oraz wykazano dodatni trend w korelacji między wskaźnikiem GS i indeksem BAd/BSA (ρ = 0,21; p = 0,076).

Wnioski. Średnice tętnic szyjnych wspólnych i średnicy ramiennej dominującej kończyny górnej są większe u pacjentów z CAD. Ultrasonografia tętnic obwodowych może stanowić uzupełniającą metodę w diagnostyce CAD.

Słowa kluczowe: choroba wieńcowa, ultrasonografia tętnic obwodowych

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