

## CLINICAL STUDY

**Ischemic disease of lower extremities – risk factors and ultrasound diagnostic**

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*IVth Department of Internal Medicine, Comenius University, Bratislava, Slovakia. bodikova@post.sk***Abstract**

We investigated 77 patients (61 men, 16 women) with clinical signs of PAOD, without previous arterial intervention, using the color duplex sonography and angiography. An average age was 63.5±11 years. We followed the risk factors of the atherosclerosis (smoking, diabetes mellitus, arterial hypertension, hyperlipidemia and obesity) and almost 86 % of the patients had multiple risk factors. We found significantly higher prevalence of smoking in men and higher prevalence of obesity in women. We found significantly higher occurrence of hemodynamically significant atherosclerotic changes in the infra-popliteal area in diabetic patients. Examination of the carotid arteries found pathologic IMT in 82 % of the patients, what confirmed common simultaneous atherosclerotic changes of carotid and lower extremities arteries, even 5.2 % of the patients had to undergo carotid endarterectomy due to the severe atherosclerotic changes. The average ABI value showed severe occlusion. We excluded diabetic patients with mediocalcinosis from the ABI evaluation. We found significant correlation between IMT and ABI values. Comparing the angiography and duplex sonography, we found 98 % sensitivity and 100 % specificity of duplex sonography in a femoro-popliteal area, but significantly lower sensitivity and specificity in an infra-popliteal area (*Tab. 1, Fig. 1, Ref. 7*) Full Text (Free, PDF) [www.bmj.sk](http://www.bmj.sk).

**Key words:** color duplex sonography, ABI, IMT and risk factors of atherosclerosis.

Atherosclerosis affects vascular system of whole body, and in the particular person can cause one or more clinical manifestations. It can cause ischemic heart disease, ischemic disease of lower extremities or stroke or transitory ischemic attack. It is very important for the clinical practice not just to diagnose the stage of atherosclerotic damage, but also to find pre-clinical states of atherosclerotic disease to be able to influence the known risk factors of atherosclerosis and to stop or slow down the manifestation of the disease. There are many invasive and non-invasive diagnostic procedures available nowadays to reveal atherosclerotic damage of the vascular system.

Atherosclerosis is the main cause of periphery artery obliterating disease (PAOD) of lower extremities and it causes the ischemia of the extremities. To find the right diagnosis in most of the cases, we need proper history taking and basic physical examination, including finding of the impaired or missing arterial pulsations, finding of vascular murmurs and of trophic changes of the skin. In cases, when medical history and physical examination are not sufficient, we use other diagnostic methods. The most common instrumental examinations are measurement of the

ankle-brachial index and use of the color duplex ultrasound. Angiography, being one of the invasive examinations, is a gold standard for description of the arterial system of the extremity including collateral vessels. This examination is indicated in all patients with planned operation reconstruction of the arteries of lower extremities.

**Patients and methods**

We analyzed the group of patients from the Department of angio-surgery examined in years 2005–2006, who were without any previous intervention procedure on arteries of lower extremities. All of the patients had clinical manifestation of ischemic

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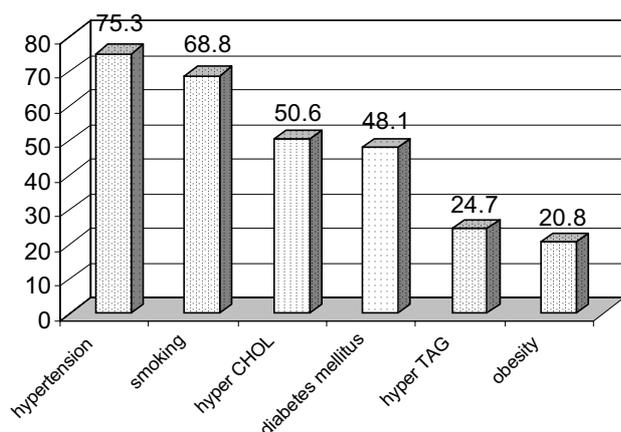


Fig. 1. Proportion of risk factors atherosclerosis.

disease of lower extremities and they were in the groups IIb–IV according to the Fountain classification. They had several years lasting history of lower extremities pain that was, even by the general practitioner, minimized especially if the pain was disappearing in the rest. The patients were often not aware of the risk factors of atherosclerosis and of their potential negative influence to the arteries of lower extremities. The reason why they came to see the doctor was either severe nocturnal pain or not-healing defects of the skin. Higher prevalence of not-healing defects of the skin was present in patients with diabetes mellitus, who however were not suffering from the severe pain due to the diabetic polyneuropathy. All of the patients had angiography examination of the lower extremity arteries due to the planned intervention procedure.

We investigated 77 patients, 61 men (79.2 %) and 16 women (20.8 %). The average age of the patients was  $63.5 \pm 11$  years. From the group of risk factors of atherosclerosis, we followed smoking, arterial hypertension, hypercholesterolemia and hypertriglyceridemia, diabetes mellitus and obesity.

IMT (intimo-medial thickness) was measured by color duplex ultrasound using 5 MHz linear probe. IMT was measured at the end of diastole on the opposite side of arteria carotis communis, 2 cm apart from bifurcation and at the area without presence of atherosclerotic plaque. We used the average value from 3 measurements for the statistical analysis.

ABI (ankle-brachial index) was calculated from the arterial blood pressure values at at the both calves and the arm using

pencil doppler ultrasound detector with 10 MHz probe. High values of ABI (more than 1.2) in diabetic patients were thought to be caused by mediocalcinosis and these patients were excluded from some statistical analysis.

We investigated arterial system of both lower extremities, from arteria femoralis communis down to the arteria dorsalis pedis and arteria tibialis posterior, using the *color duplex ultrasound* with 5 MHz probe. Arterial system of lower extremities was divided into the two parts: central part including femoro-popliteal segment and peripheral part including infrapopliteal segment. Occlusion of the artery, or stenosis more than 50 % was considered as a hemodynamically significant damage. For the quantification of stenosis, we used ratio of maximal systolic velocity in a place of stenosis and above the stenosis (PSVR). If PSVR was more than 2, we stated 50 % stenosis. It was possible to do this accurate quantification only in femoropopliteal segment. We were not able to visualize arteries of the infrapopliteal segment in all their parts due to the low performance of the ultrasound detector and so we used spectral analysis of the flow to consider the hemodynamic significance of the atherosclerotic damage. Monophasic flow found in arteria dorsalis pedis and arteria tibialis posterior with decreasing amplitude was considered as hemodynamically significant.

Angiography was done by digital subtraction method in a Department of radiology. We evaluated both lower extremities, and the arterial system was divided into the two segments again.

## Results

The main goal of our study was to compare findings of atherosclerotic changes in lower extremities using angiography (invasive examination) and color duplex ultrasound (non-invasive examination) and to find sensitivity and specificity of color duplex ultrasound examination. 26 % of patients had atherosclerotic changes only in femoropopliteal segment and 23.4 % patients only in infrapopliteal segment and in 50.6 % of patients we found atherosclerotic changes in central and peripheral segment. In 35 % of patients was affected only one lower extremity. We found 98 % sensitivity of color duplex ultrasound examination and 100 % specificity in femoropopliteal segment. In peripheral segment we found 94.6 % sensitivity and 66 % specificity of color duplex ultrasound examination.

Hypertension was the most common risk factor of atherosclerosis found in our group of patients (75.3 %). The other was

Tab. 1. Risk factors in the groups.

	Total number	HyperCHOL	HyperTAG	Hypertension	Obesity
S(+) DM(+)	17	11 (64.7 %)	7 (41.2 %)	15 (88.2 %)	1 (5.9 %)
S(+) DM(-)	36	19 (52.8 %)	5 (13.9 %)	23 (63.9 %)	8 (22.2 %)
S(-) DM(+)	20	6 (30 %)	7 (35 %)	16 (80 %)	6 (30 %)
S(-) DM(-)	4	3 (75 %)	0 (0 %)	4 (100 %)	1 (25 %)
p value		NSNS(P=0,66)NSNS			

smoking (68.8 %), hypercholesterolemia (50.6 %) and diabetes mellitus (48.1 %). The patients with diabetes mellitus type 2 were treated in 25 % by insulin, the rest of them were treated by diet and per-oral anti-diabetic drugs. The occurrence of risk factors of atherosclerosis is shown in Figure 1. We found significantly higher prevalence of smoking in men (79.2 %) than in women (20.8 %) and significantly higher prevalence of obesity in women (43.8 %) than in men (14.8 %). There were no significant differences in other risk factors between men and women. The only one risk factor of atherosclerosis was present in 11 patients (14.3 %). More than one risk factor was present in 66 patients (85.7 %). More than 2 risk factors were present in 42 patients (54.5 %). More than 3 risk factors were present in 24 patients (31.2 %). Considering the presence of multiple risk factors, we split our group of patients into the 4 groups:

- smokers and diabetics (S+DM+) 17 patients (22.1 %),
- smokers and non diabetics (S+DM-) 36 patients (46.7 %),
- non smokers and diabetics (S-DM+) 20 patients (26 %),
- non smokers and non diabetics (S-DM-) 4 patients (5.2 %).

We chose this two risk factors due to their known relationship to the damage of the arteries of lower extremities. Smoking is one of the risk factors leading particularly to the central damage of arteries, while diabetes mellitus usually causes peripheral damage. The presence of the other risk factors in these 4 groups of patients was different (Tab. 1). We found borderline higher prevalence of hypertriglyceridemia in diabetic patients, what may be linked with their not sufficient compensation.

All of the patients were examined by angiography, what is the most exact method for detection of atherosclerotic damage of arteries. The patients were examined also by color duplex ultrasound examination (representative of non-invasive examinations) and we examined arteries of lower extremities and carotid arteries (measuring IMT). The damage of the infrapopliteal segment of arteries was the most common in the group of patients with smoking and diabetes mellitus. In 94 % of these patients we found damage of peripheral arteries using angiography, while ultrasound examination showed 100 % occurrence of peripheral damage. 62.2 % of diabetic patients had peripheral damage in both lower extremities.

All of the patients had examined carotid arteries by ultrasound examination, as there is known correlation between damage of arteries of lower extremities and of carotid arteries. In our group of patients we found pathologic IMT  $\geq 0.9$  mm in 81.8 % of patients.

14 patients had ABI higher than 1.2. All of these patients were diabetics, however it is known, that occurrence of mediocalcinosis is higher in diabetics, and it might have impact on our results. ABI seems to be not adequate method for evaluation of atherosclerotic damage in these patients with mediocalcinosis. We excluded patients with overestimated values of ABI from our statistical analysis. The average value of ABI was 0.4 in our group of patients what shows severe degree of occlusion. We found significant correlation between IMT value and ABI ( $r = -0.287$ ,  $p < 0.05$ ).

53 patients (68.8 %) from our group were treated by the operation. In 44 patients (57.1 %) was done revascularization pro-

cedure (PTA, endarterectomy or bypass). 9 patients (11.7 %) were indicated for the amputation of the leg. All of the patients indicated for the amputation were diabetics. 24 patients (31.2 %) were not treated by operation – in 15 of them improvement occurred after the infusion therapy, and in 5 of them revascularization procedure was not able to be done due to the severe atherosclerotic damage. In 4 patients was simultaneously found severe stenosis of carotid arteries and so they had to have carotid endarterectomy done first.

## Discussion

Atherosclerosis is a progressive process affecting arterial walls of whole body. This process is slow and lasts for many years. It affects big and middle-size arteries. The first clinical signs of atherosclerosis can be seen at about 50 years of age. Clinical manifestation of atherosclerosis, e.g. ischemic heart disease, ischemic disease of lower extremities or stroke, is advanced and severe complications of atherosclerosis. Clinical manifestation from one body system indicates atherosclerotic affection of whole arterial system. Periphery artery disease (with most common representative - ischemic disease of lower extremities) is an independent predictor of increased mortality in patients with ischemic heart disease (1). Early detection of this disease and modification of some risk factors of atherosclerosis can slow down this process (2). The signs of ischemic disease of lower extremities are often underrated in early stages. For 100 patients with verified ischemic disease of lower extremities, there are 100 other patients who are not aware of their disease.

Good screening method for detection of early – asymptomatic stages of atherosclerosis is ABI examination. This examination is non-invasive, simple and cheap and can detect ischemic disease of lower extremities in asymptomatic patients. This examination can also be used for long time follow-up of patients with already known vascular disease, or after the revascularization procedure. Despite the advantages of ABI examination, its simplicity and low expenses, this examination is still available only in specialized angiology or angiosurgery ambulances. There are many new studies that showed that ABI examination is a good screening method for early detection of ischemic disease of lower extremities in asymptomatic diabetic patients (3, 4). They found ischemic disease of lower extremities in 29 % of diabetics above 50 years. The limitation of this examination is already mentioned mediocalcinosis (5). We found very low values of ABI in our group of patients, however all of these patients were with angiography verified ischemic disease of lower extremities and were indicated for the intervention procedure.

Color duplex ultrasound examination of carotid arteries is a simple, non-invasive, reproducible and not time consuming method that can be realized also by the machine with worse quality (6). Considering the common simultaneous changes of carotid arteries in patients with ischemic disease of lower extremities, this examination should be done in all these patients as a screening method (7). All patients hospitalized in our department due to the ischemic disease of lower extremities have examined their

carotid arteries by color duplex ultrasound examination. IMT examination is an important examination for detection of early stages of atherosclerosis; however it is not sufficient in patients with severe damage of arteries. It is measured in a particular part of arterial wall and at a place of arterial wall without an atherosclerotic plaque. IMT value does not describe damage of the other parts of arterial wall, does not show hemodynamically significant changes of arteria carotis communis and interna. In addition to the spectral analysis of the flow curves and to the measurement of the degree of stenosis, it is also important to describe the morphology of the atherosclerotic plaque. Some patients are indicated for the carotid endarterectomy even with light degree of stenosis, however with inhomogeneous and with ulcerated plaques that tend to thrombosis. Increased IMT indicates atherosclerotic damage of the vascular system of the whole body, and we can not use it to state the level of carotid arteries damage.

Comparing the angiography and color duplex ultrasound examination, we found high sensitivity and specificity of color duplex ultrasound examination in femoropopliteal segment, however its insufficiencies in infrapopliteal segment. This examination is influenced by the quality of the machine, by the experience of the examiner and this examination is also „time consuming“. Color duplex ultrasound examination is not able to replace angiography. It can be used for indication of revascularization in cases when angiography is contra-indicated, especially in femoropopliteal segment.

Our study showed participation of the main risk factors of atherosclerosis in ischemic disease of lower extremities. The most important were smoking and diabetes mellitus. Ischemic disease of lower extremities, as a clinical manifestation of atherosclerosis, can not be underrated. This disease should be searched in the high risk patients and modification of the risk factors can restrict the transition to the advanced stages. However, this form

of the clinical manifestation of atherosclerosis is still underrated and late diagnosed.

We can expect stabilization of the disease in 50 % of the patients. 25 % has to undergo revascularization procedure, and 4 % of the patients have to undergo amputation. We also can expect deterioration of the symptoms in some 15 % of the patients, and critical ischemia is quite common (1 %) (2). Approximately 30 % of the patients die in 5 years due to the cardiovascular complication (myocardial infarction, stroke).

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