Aortoiliac and femoropopliteal lesions in patients with concomitant peripheral arterial disease and medial arterial calcification

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Abstract

Objective: To characterize stenosis and/or occlusion in patients with concomitant peripheral arterial disease (PAD) and medial arterial calcification (MAC). Patients and methods: We performed continuous-wave Doppler technique (to measure the ankle-brachial index - ABI) and duplex ultrasonography in 75 consecutive patients at risk for PAD (57 males, age 72.6±6.3 years) admitted to a Medical Clinic between January and March 2006. Group A was composed of 15 subjects with plaques and ABI higher than 1.3 (MAC - 20%). Normal ABI was found in 43 patients (group B - 57.33%). Group C included 17 patients with ABI lower than 0.9 (ischemia - 22.67%). Results: Nonsignificant aortoiliac stenosis (less than 50%) was found in 70 subjects (15 in group A, 39 in group B, and 16 in group C - nonsignificant). Significant femoropopliteal stenosis (greater than 50%) was detected in eight patients (five in group A, one in group B, and two in group C – p<0.001). Nonsignificant femoropopliteal stenosis was identified in 54 subjects (seven in group A, 42 in group B, and five in group C - p<0.001). Conclusion: Significant femoropopliteal stenosis significantly correlated with presence of MAC. Nonsignificant femoropopliteal stenosis was identified in patients with normal ABI.

Key words: peripheral arterial disease, medial arterial calcification, ankle-brachial index

Rezumat

Obiectiv: Analiza caracteristicilor stenozei și/sau ocluziei la pacienții cu arterioapatie obliterantă periferică și mediocalcinoză. Pacienți și metodă de lucru: Am efectuat tehnicile Doppler continuu (pentru determinarea indicelui de presiune sistolică gleznă-braț – IPS) și duplex la 75 pacienți consecutivi cu risc de arterioapatie (57 bărbați, vârstă 72.6±6.3 ani) internați într-o Clinică Medicală în perioada ianuarie-martie 2006. Cei 15 subiecți cu plăci și IPS peste 1,3 (mediocalcinoză) au format grupul A (20%). Grupul B a inclus 43 pacienți cu IPS normal (57.33%). Grupul C a cuprins 17 pacienți (22.67%) cu ischemie (IPS sub 0,9). Rezultate: Stenoza aortoiliacă nesemnificativă (sub 50%) a fost depistată la 15 pacienți din grupul A, 39 din grupul B și 16 din grupul C (nesemnificativ). Stenoza femoropoplitee semnificativă (peste 50%) a fost identificată la opt subiecți din grupul A, unul din grupul B și doi din grupul C (p<0.001). Stenoza femoropoplitee nesemnificativă a fost diagnosticată la șapte bolnavi din grupul A, 42 din grupul B și cinci din grupul C (p<0.001). Concluzii: Stenoza femoropoplitee semnificativă s-a corelat cu prezența mediocalcinozei. Stenoza femoropoplitee nesemnificativă a fost diagnosticată la pacienții cu IPS normal.

Cuvinte cheie: arterioapatie obliterantă periferică, mediocalcinoză, indice de presiune sistolică gleznă-braț

Introduction

Peripheral arterial disease (PAD) is characterized by stenosis, occlusion and aneurysm of the aorta, visceral branches, and arteries of the legs due to atherosclerosis and thromboembolism [1]. The results of the Cardiovascular Health Study and of the Atherosclerosis Risk in
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Communities Study (ARIC Study) have shown that PAD is increasing cardiovascular morbidity and mortality, and all-cause mortality [2,3]. All risk factors for atherosclerosis (particularly increasing age, current smoking, arterial hypertension, diabetes, and dyslipidemia) are, at the same time, traditional independent risk factors for PAD [4,5]. Therefore, the European Society of Hypertension and the European Society of Cardiology strongly recommend ankle-brachial index (ABI) as a test for the evaluation of patients with hypertension [6]. A value lower than 0.9 is associated with a two- to three-fold increased risk of cardiovascular mortality so that ABI may improve the accuracy of cardiovascular risk prediction, reclassify the Framingham risk categories and modify the treatment recommendations [7,8]. The positive correlation between PAD, coronary artery disease and carotid stenosis is well known [9-11].

Medial artery calciﬁcation (MAC) is a non obstructive arterial disease. It produces signiﬁcant stiffening of the arterial wall heavily calcified and reduces its response to vasodilator stimuli [4,12]. This disease, unrelated to cardiovascular risk factors, is associated with elevated cardiovascular morbidity and mortality in patients with diabetes mellitus and/or end-stage renal failure. Patients with MAC may have falsely elevated ABI (higher than 1.3) due to reduced arterial compliance, so that associated ischemia cannot be diagnosed [7,13,14].

Despite numerous studies, the knowledge of the prevalence of MAC in patients with PAD is limited [13].

Aims

We investigated the localization of the arterial lesions (stenosis and occlusion) and the degree of stenosis in patients with concomitant PAD and MAC.

Patients and methods

The study was conducted at the Department of Internal Medicine, Municipal Hospital, 5th Medical Clinic, „Iuliu Haţieganu” University of Medicine and Pharmacy Cluj-Napoca, Romania between January and March 2006.

There were three inclusion criteria related to the indication for performing ABI: patients with arterial hypertension - ABI is recommended by the European Task Force for the Management of Arterial Hypertension [6] or with diabetes mellitus – the guidelines recommend that the test should be used as screening for hemodynamically signiﬁcant disease [16] or subjects at risk for PAD [1]. There are six criteria for the risk diagnosis for PAD: age less than 50 years with diabetes and other risk factors (smoking, dyslipidemia, or hypertension) or age 50 to 69 years and history of smoking or diabetes or age over 70 years or leg symptoms (claudication, rest pain) or modified leg pulses or known artery disease (coronary, carotid, or renal) [1]. We used a continuous Doppler machine Kranzbühler Digidop 2.

A total of 75 consecutive patients met the criteria for inclusion in this study. Depending on the value of ABI, patients were divided into three groups: A (ABI higher than 1.3 - MAC), B (normal value of ABI: 0.9-1.3), and C (resting ischemia deﬁned by ABI lower than 0.9).

Duplex ultrasonography was performed in all patients irrespective of ABI and served to analyze the arterial wall (plaques with stenosis lower or more than 50%) and the lumen (occlusion). The arterial circulation of the lower extremity was divided into three segments – aortoiliac, femoropopliteal, and tibioperoneal. All patients had stenoses and/or occlusion. We used, as duplex machines, the Aloka Prosound SSD-400 and General Electric Logiq 500.

The following parameters were analyzed in all patients: demographic data (gender, age), clinical data (intermittent claudication, rest pain, skin changes – color, temperature, trophic lesions, absent or diminished pulses, femoral bruits, Fontaine’s stages, history of smoking, diabetes, hypertension, or dyslipidemia, body mass index, abdominal circumference), morphological data (stenosis, occlusion, wall echogenicity, acoustic shadow), hematologic tests (complete blood count, coagulation), biochemical tests (fasting blood glucose and lipid proﬁle, serum creatinine, proteinuria), resting electrocardiogram and echocardiogram, carotid duplex scan, and fundoscopy. We did not perform toe pressure measurement in patients with MAC.

Statistical analysis was performed using the Epi Info computer package, version 3.3.2. We calculated percents for categorical variables and means and standard deviations for continuous variables. Comparative analysis of qualitative variables was made using χ2 test. The ANOVA test was used to compare the differences between the mean values and to calculate standard deviations. A P value less than 0.05 was considered the level of statistical significance.

Results

All background characteristics of the sample are presented in Table 1.

All the 75 patients included in the study had nonsigniﬁcant arterial lesions (aortoiliac and/or femoropopliteal stenosis less than 50%). A total of 24 patients (32%) had, in addition, hemodynamically signiﬁcant arterial lesions.
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(aortoiliac and/or femoropopliteal stenosis greater than 50%, tibioperoneal stenoses, aortoiliac or femoropopliteal occlusion).

Concomitant aortoiliac and femoropopliteal involvement was encountered in 58 patients (77.32%). A total of 6 patients had simultaneous aortoiliac and tibioperoneal lesions. Only two subjects had femoropopliteal and tibioperoneal involvement. Two patients had impaired circulation of the three segments of the legs (aortoiliac, femoropopliteal, and tibioperoneal).

Femoral stenoses less than 50% were frequent (fig 1).

All patients with MAC had hyperechoic tibial arteries (fig 2).

Some of the subjects had also strong echogenicity of the muscular and superficial femoral arteries (fig 3, fig 4).

All data of patients from the three groups (A, B, and C) are presented in Table 2.

Table 1. Characteristics of patients with PAD

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75</td>
</tr>
<tr>
<td><strong>Demographic data</strong></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>45 (60%)</td>
</tr>
<tr>
<td>Age (mean ± standard deviation; range)</td>
<td>72.60 ± 6.3 years (44-79)</td>
</tr>
<tr>
<td><strong>Clinical data</strong></td>
<td></td>
</tr>
<tr>
<td>Stage I</td>
<td>53 (70.67%)</td>
</tr>
<tr>
<td>Stage II</td>
<td>19 (25.33%)</td>
</tr>
<tr>
<td>Stages III and IV</td>
<td>3 (4%)</td>
</tr>
<tr>
<td><strong>ABI</strong></td>
<td></td>
</tr>
<tr>
<td>&gt;1.30</td>
<td>15 (20%)</td>
</tr>
<tr>
<td>0.91-1.30</td>
<td>43 (57.33%)</td>
</tr>
<tr>
<td>&lt;0.90</td>
<td>17 (22.67%)</td>
</tr>
<tr>
<td><strong>Arterial lesions</strong></td>
<td></td>
</tr>
<tr>
<td>Aortoiliac stenosis &lt;50%</td>
<td>70 (93.33%)</td>
</tr>
<tr>
<td>Femoropopliteal stenosis &lt;50%</td>
<td>54 (72%)</td>
</tr>
<tr>
<td>Femoropopliteal occlusion</td>
<td>14 (18.66%)</td>
</tr>
<tr>
<td>Femoropopliteal stenosis &gt;50%</td>
<td>8 (10.66%)</td>
</tr>
<tr>
<td>Tibioperoneal stenosis</td>
<td>6 (8%)</td>
</tr>
<tr>
<td>Aortoiliac stenosis &gt; 50%</td>
<td>1 (1.33%)</td>
</tr>
<tr>
<td>Aortoiliac occlusion</td>
<td>1 (1.33%)</td>
</tr>
<tr>
<td><strong>Risk factors for atherosclerosis</strong></td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>60 (80%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>53 (70.66%)</td>
</tr>
<tr>
<td>Smoking</td>
<td>46 (61.33%)</td>
</tr>
<tr>
<td>Hypo HDL-cholesterol</td>
<td>41 (54.66%)</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>18 (24%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>9 (12%)</td>
</tr>
<tr>
<td><strong>Comorbidities</strong></td>
<td></td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>72 (96%)</td>
</tr>
<tr>
<td>Carotid artery disease</td>
<td>66 (88%)</td>
</tr>
</tbody>
</table>

Figure 1. Long-axis view of the right common and superficial femoral arteries. Heterogenous plaques with irregular surface on the posterior wall. AFC: common femoral artery. AFS: superficial femoral artery. AFP: deep femoral artery.

Figure 2. Longitudinal and transverse images of the right posterior tibial artery. Hyperechoic arterial wall with acoustic shadow. ATP: posterior tibial artery. VTP: posterior tibial vein.

Figure 3. Short-axis view of the left calf. Prone position. Soleal artery with hyperechoic wall with shadowing. Art soleara: soleal artery.
Of the 75 patients included in the study, 40 were men. The male-to-female ratio was 1.5. This value is little different from the sex ratio found in recent large studies. There are no clear differences between men and women in the prevalence of PAD diagnosed based on ABI. The male-to-female ratio found in the Framingham Offspring Study and in the Rotterdam Study was 1.18 and 0.82, respectively [17,18]. When only group B was taken into consideration, the male-to-female ratio was 0.86.

Over two thirds of patients had no pain. All patients included in group B had Fontaine stage I. Without duplex technique, hemodynamically nonsignificant arterial lesions remain undiagnosed. Only 25% of patients had intermittent claudication (they were part of groups A and C). In the Rotterdam Study, 6.3% of patients with PAD (8.7% of men and 4.9% of women) reported intermittent claudication [18]. McDermott et al. reported that only 10% to 30% of patients with ABI below 0.90 have this type of pain [7]. Fontaine stages III and IV were encountered only in three patients because, in general, patients with chronic critical ischemia are admitted into surgical clinics for revascularization or amputation.

Over half of the patients had normal ABI. Unfortunately we could not perform the treadmill exercise. This test could have been important in the alteration of the number of patients in groups B and C because ABI could fall by at least 0.10 post exercise in patients with hemodynamically nonsignificant plaques at rest [19,20].

Approximately 33% of patients with nonsignificant arterial disease had also hemodynamically significant lesions (stenosis greater than 50% or occlusion). The patients included in group C had the most important lesions. Sacks et al. showed that the decrease of ABI correlates with the severity of arterial disease [15]. All patients from group B had at least nonsignificant femoropopliteal stenosis (p<0.0001).

A total of 5 subjects in group A (33.33%) had also femoropopliteal stenosis greater than 50% (p=0.004). We found no explanation in the medical literature. The association between nonsignificant and/or significant aortoiliac and femoropopliteal diseases, found in 58 patients (77.32%) was the most common combination of segmental lesions. Vogt et al. (1993) found this two-segment disease in 18% of men and 22% of women [21]. Two patients had three-segment disease (aortoiliac, femoropopliteal, and tibioperoneal disease). Vogt’s study showed that 2% of men and 3% of women had this kind of disease [21].

There were no statistically significant differences between the three groups concerning the frequency of hypertension, hypercholesterolemia, current smoking,
abdominal obesity, and diabetes. Diabetes was diagnosed in 9 patients with PAD (12%) and in 4 subjects with PAD and MAC (p=0.15). It is known that MAC is associated with diabetes mellitus, chronic renal insufficiency, and older age [13,14].

Some data from the literature are inconclusive. In the Rotterdam Study, current smoking and hypertension were more frequent in persons with ABI lower than 0.90 than in subjects with normal or higher ABI [18]. A total of 4393 American Indians were included in the Strong Heart Study and followed up for 8.3±2.2 years. Diabetes was found in 60.2% of patients with ABI lower than 0.90 and in 67.8% of subjects with ABI greater than 1.30 (nonsignificant). The prevalence of hypertension in the two groups was 50.1% and 45.1%, respectively [22]. Vogt et al. (1993) found that diabetes was significantly associated with tibio-opeoneal disease. Aortoiliac lesions and femoropopliteal disease was associated with a high frequency of current smoking and hypertension [21]. Nosenko et al. (2003) examined 68 patients (40 of them were diabetics). There were no significant difference concerning the frequency of aortoiliac and popliteal disease between patients with and without diabetes [23]. Kröger et al. (2006) presented their study on 4735 German subjects aged 45-75 years. Patients were followed up for four years. In contrast with PAD, the prevalence of MAC did not increase with age [24].

The highest frequency of hypo HDL – choleste- rolemia was encountered in 14 out of 15 patients in group A (93.33%). We found no explanation in the literature.

Ischemic heart disease and asymptomatic carotid artery disease were very frequent (96% and 88%, respectively) without differences between groups. It is known that patients with PAD are more likely to have other atherosclerotic disorders [25]. In fact The American Society of Neuroimaging and the Society of Vascular and Interventional Neurology recommend screening for asymptomatic carotid artery stenosis in patients with PAD and/or hypertension [26].

**Limitations**

We did not perform some investigations (the estimated glomerular filtration rate, microalbuminuria, provoked – hyperglycemia test, treadmill exercise, and toe-brachial index).

**Conclusion**

Significant femoropopliteal stenosis and hypo HDL–cholesterolemia significantly correlated with the presence of MAC. Nonsignificant femoropopliteal stenosis was identified in patients with normal ABI.

**References**


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