

Screening test for extracranial carotid lesions' detection in patients of an outpatient vascular clinic

Authors' Contribution:
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B – Data Collection
C – Statistical Analysis
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ABSTRACT:

Purpose: The objective of the study was to evaluate the frequency and severity of atherosclerotic lesions in extracranial sections of carotid arteries and to determine the level of the correlation between these lesions and symptoms of cerebral ischemia. Secondly, to identify the most common risk factors of ischaemic stroke occurrence in the population of patients of a vascular outpatient clinic.

Material and Methods: Prospective study was conducted on a group of 1,000 people (217 women and 783 men), aged 50 to 86 years, the average age being 62 years (± 9.95).

Results: Atherosclerotic lesions of carotid arteries were observed in 670 examined individuals (67%). In 63 cases (6.3%) carotid artery occlusion was revealed. Patients with symptomatic carotid artery stenosis more frequently were addicted to cigarettes and suffered from hypertension in comparison to the asymptomatic group. A statistically significant correlation between the TIA or ischemic stroke and smoking were noticed, as well as between TIA/ischemic stroke and hypertension.

Conclusions: Among patients with atherosclerosis of the peripheral arteries, atherosclerotic lesions in the extracranial carotid sections occur with a high frequency. Statistically significant differences in the incidence and severity of atherosclerotic lesions in the carotid arteries were observed in this group. A statistically significant correlation was revealed between the prevalence and severity of atherosclerosis in the carotid arteries in symptomatic patients and smoking and hypertension. Screening in patients with atherosclerosis of the abdominal aorta and/or lower limb arteries may detect significant carotid artery stenosis, requiring surgical intervention.

KEYWORDS:

atherosclerotic lesions, abdominal aorta aneurysm, carotid artery stenosis, screening tool, vascular surgery

ABBREVIATIONS

AAA – abdominal aorta aneurysm

AAA+AS – abdominal aorta aneurysm and atherosclerosis lesions in the abdominal aorta and/or in the arteries of the lower extremities

AF – amaurosis fugax

AS – isolated atherosclerosis lesions in the abdominal aorta and/or in the arteries of the lower extremities

CA – carotid arteries

IHD – Ischemic heart disease

SD – standard deviation

TIA – transient ischemic attack

WHO – World Health Organization

Introduction

According to the WHO, cerebral stroke is the second most common cause of death and a common cause of permanent disability of people in the world [1–12]. Therefore, it constitutes a serious clinical, social and economic problem on a global scale [13–23]. In 20% of cases, ischemic cerebral stroke is caused by the presence of atherosclerotic lesions in the CA [24]. It is estimated that in the whole population such lesions occur even with a frequency of 10% [25, 26]. The discussion on the importance of screening for the detection of carotid artery stenosis and the role of surgery in the prevention of cerebral ischemic stroke has been going on for many years [27–33]. The main problem is the high cost of diagnosis and

the difficulty in finding a target population of patients at increased risk of extracranial arteries' atherosclerosis [34–36]. It is necessary to define the patient population in which certain risk factors or comorbidities could increase the chance of carotid atherosclerosis and cerebral ischemic stroke [37, 38]. This would let to apply appropriate methods of prevention of stroke and possibly improve the treatment results [39, 40]. There are still ongoing attempts to find an appropriate sensitive method for diagnosis and identification of patients with a high risk of cerebral stroke [31, 41–49].

The main objective of the study was to evaluate the frequency and severity of atherosclerotic lesions in extracranial sections of carotid arteries in patients of Peripheral Vascular Disease Outpatient Clinic and to determine the level of the correlation between these lesions and symptoms of cerebral ischemia. An additional aim of the study was to identify the most common risk factors of ischaemic stroke occurrence in the population of vascular outpatient clinic.

MATERIAL AND METHODS

This prospective study was conducted on a group of 1,000 people (217 women and 783 men), aged 50 to 86 years, the average age being 62 years (± 9.95), treated in the Peripheral Vascular Disease Outpatient Clinic, Provincial Multidisciplinary Center of Oncology and Traumatology, Copernicus Memorial Hospital, Lodz. The group consisted of people who suffered from chronic diseases of the abdominal aorta and the arteries of the lower extremities. In

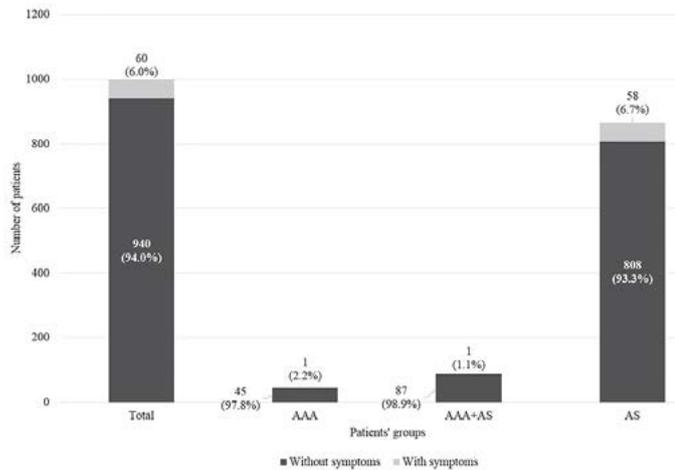


Fig. 1. The presence of symptoms in the examined groups.

all consecutively presenting to an outpatient clinic patient, extracranial sections of the CA were assessed during routine ultrasound examinations of the abdominal aorta and arteries of the lower extremities. Tests were performed in the Laboratory of Diagnostic Imaging, always by the same, experienced doctor, using an ultrasound camera (TOSHIBA Type Power Vision 6000, model SSA-370A), equipped with a linear array transducer (model PLM – 805 AT 8 – 12 MHz) and convex array transducer (model PVM – 375 AT, 3 to 6 MHz). In the two-dimensional longitudinal and transverse projection, the severity of atherosclerosis in the carotid arteries was assessed. The degree of stenosis calculated with the method used in the NASCET study (North American Symptomatic Carotid Endarterectomy Trial Collaborators) of the extracranial carotid artery sections was the basis for qualification of the patients to one of the six groups:

- without atherosclerotic lesion (0%),
- low-grade and medium-grade stenosis hemodynamically insignificant (<50%),
- medium-grade stenosis hemodynamically significant (50–69%),
- high-grade stenosis (70–99%),
- artery occlusion (100%).

During ultrasound examination of CA, the characteristics and structure of atherosclerotic plaques were evaluated. Based on the anamnesis, concerning the last 6 months before the survey, a history of cerebral ischemic stroke and TIA was taken. It was used for the division of the analyzed patients into two groups:

- A – symptomatic (with positive neurological history): 60 cases (6%), including 9 women (15%) and 51 men (85%), mean age 67.43 ± 10.2 ;
- B – asymptomatic (with negative neurological history): 940 people (94%), including 208 women (22.13%) and 732 men (77.87%), mean age 60.74 ± 10.3 .

Additional information obtained on history taking included: age, gender, atherosclerosis risk factors (cigarette smoking – present or in the past, diabetes – treated, arterial hypertension, hypercholesterolemia), cardiovascular disease (ischemic heart disease, previous myocardial infarction). All patients with diagnosed chronic diseases obtained an adequate pharmacological treatment.

Statistical analysis

The results were subjected to statistical analysis using Excel and Statgraphics Plus v. 5.0 software. The patients' structure estimated according to the observed features was determined using percentages. The studied group of patients was described using stratum weights for the qualitative features. For quantitative features the arithmetic mean (X_m) was calculated as an average value and SD. Test for two means was used to compare the calculated arithmetic means. The difference between studied parameters was considered statistically significant, when the calculated test value was equal or greater than the critical value obtained from chi-square tables (normal, t-test) with appropriate number of degrees of freedom and error probability of less than 0.05. The correlation significance was assessed by Student's t-test with 2 degrees of freedom.

RESULTS

Among the analyzed group of 1000 patients, there were 46 individuals (4.6%) with AAA, 88 patients (8.8%) with AAA+AS and 866 patients (86.6%) with AS. Patients with symptomatic carotid artery stenosis were more frequently addicted to cigarettes ($P < 0.01$) and suffered from hypertension ($P < 0.001$) in comparison to the asymptomatic group. No statistically significant differences were observed among these two groups in relation to the occurrence of hyperlipidemia, diabetes and ischemic heart disease ($P > 0.05$) (Tab. I.).

The group of symptomatic patients consisted of 60 individuals (6.0%), including 1 patient with AAA without carotid artery stenosis and 1 patient with AAA+AS and with carotid artery stenosis >70%. The remaining 58 symptomatic individuals were patients with atherosclerosis in the aorta or in the arteries of the lower extremities (AS). The group of asymptomatic patients included 940 individuals (94%) – 45 cases with AAA, 87 cases with AAA+AS and 808 cases with AS. The presence of neurological symptoms in the analyzed population of patients is presented in Fig. 1.

In the group of symptomatic patients, carotid artery stenosis above 50% and 70% was detected in 15 (25%) and 13 (21.7%) patients, respectively. Occlusion of carotid arteries was diagnosed in 11 cases (18.3%) in this group. In the asymptomatic patients, CA stenosis above 50% and 70% was revealed in 118 (12.6%) and 49 (5.2%) patients, respectively. CA occlusion in this group was diagnosed in 52 cases (5.5%). The above information was summarized in Tab. II.

The frequency of carotid artery lesions did not differ significantly for symptomatic patients (who underwent TIA or cerebral stroke) and asymptomatic patients ($P > 0.05$). However, carotid artery lesions above 50% and above 70% were significantly more frequent in the group of symptomatic patients ($P < 0.01$ and $P < 0.001$).

A statistically significant difference ($P < 0.001$) was also observed between the presence of a high degree of CA stenosis (above 50% and 70%) and its occlusion in both groups of patients.

A statistically significant correlation between the presence of carotid artery stenosis and smoking ($P < 0.005$), arterial hypertension ($P < 0.05$) and ischemic heart disease ($P < 0.005$) was noticed. There was no statistically significant correlation between patients

Tab. I. Analyzed group characteristics.

GROUP CHARACTERISTICS	TOTAL		SYMPTOMATIC		ASYMPTOMATIC		STATISTICAL ANALYSIS
	N	%	N	%	N	%	
Mean age	62.15 ± 9.95		67.43 ± 10.20		60.74 ± 10.30		p > 0.05
Sample size	1000	100	60	6.0	940	94.0	
Sex							
Men	783	78.3	51	85.0	732	77.9	p > 0.05
Women	217	21.7	9	15.0	208	22.1	
Risk factors							
Smoking	710	71.0	52	86.7	658	70.0	p < 0.01
Hypertension	270	27.0	28	46.7	242	25.7	p < 0.001
Hyperlipidemia	51	5.1	6	10.0	45	4.8	p > 0.05
Diabetes	108	10.8	9	15.0	99	10.5	p > 0.05
IHD	142	14.2	13	21.7	129	13.7	p > 0.05

with hypercholesterolemia and patients with a history of diabetes mellitus (Tab. III.). Mean time of performance of CA ultrasound was 3 minutes (± 2).

DISCUSSION

Based on epidemiological data published worldwide it was estimated that in 2013, 25.7 million people suffered from cerebral stroke, and 6.5 million people died because of that [4]. It was assessed that 25–74% of patients after stroke require constant care of other people and rehabilitation [50]. About 70% of cases of stroke have an ischemic nature (IS), including 20% of the cases that are caused by atherosclerosis in the cerebral and carotid arteries [4, 24]. In the entire population these types of lesions occur in 5 to 10% of examined people [25]. Based on other studies, the incidence of asymptomatic stenosis of CA depends on the age and ranges from 0.5% before 60 years of age, to 10% above 80 years of age [26].

In the analyzed group of patients of the Vascular Outpatient Clinic, the atherosclerotic lesions in CA were found in 67% (670) of patients, while in 13.3% (133) stenosis above 50% was detected and in 6.2% (62) stenosis above 70%. Among symptomatic patients' stenosis in carotid arteries occurred in 40 cases (66.7%), stenosis >50% was observed in 15 patients (25%), and >70% – in 13 patients (21.7%). In asymptomatic patients the overall incidence of carotid lesions was similar – they were diagnosed in 67% of cases (630 patients). The high-grade stenosis appeared significantly more rarely. Stenosis >70% was present in 49 asymptomatic patients, which constitutes 5.2% of this group.

Nearly 97% of all symptomatic patients (58 cases) had isolated atherosclerosis of the abdominal aorta or atherosclerotic lesions in the arteries of the lower limbs (AS). Patients with AAA and AAA + AS had confirmed symptoms of CNS ischemia in only 3% (2) of cases. This is most likely due to the different nature of atherosclerosis of extracranial and intracranial carotid artery versus aortic aneurysms. Among symptomatic patients, stenosis of CA above 50% and 70% occurred more frequently than in asymptomatic individuals. This allows to state that patients with chronic diseases of the abdominal aorta and/or lower limb arteries are threatened by the presence of lesions in the carotid arteries and should undergo a screening of CA. The analysis found statistically significant

differences in the distribution of the frequency of lesions in the carotid arteries in patients with a history of cerebral accidents, compared to those without neurological symptoms in the anamnesis. The observed dependency was observed for the whole group of patients with neurological disorders (TIA or stroke), as well as for the analysis performed separately for these events. CA stenosis, including the high-degree one, was found more frequently and was higher in symptomatic patients than in asymptomatic ones. This means that there is a strong positive correlation between the presence of high CA stenosis and the symptoms of cerebral ischemia. This indicates a need for testing the carotid arteries of each symptomatic patient with a history of acute cerebrovascular incidents. Risk factors for stroke, defined in 1998 by the National Society for Stroke in the US, which include hypertension, diabetes, hyperlipidemia, smoking, alcohol consumption, low physical activity and diet are the same as risk factors for heart attacks and peripheral vascular atherosclerosis [51, 52].

In the analyzed population of patients with peripheral vascular disease a comparison of the incidence of TIA and stroke between smokers and those who denied smoking, showed statistically significant differences ($P < 0.01$). It seems that cigarette smoking not only affects the frequency and nature of atherosclerotic lesions within the carotid arteries, but also significantly increases the risk for cerebral stroke. In the group of patients with hypertension, incidents of cerebral ischemia were significantly more frequent than in those with normal blood pressure, and the observed differences were statistically significant ($P < 0.001$). It should be noted that in the study population hypertension significantly increased the risk of CNS ischemia. The occurrence of diabetes in the analyzed group did not increase in a statistically significant manner the occurrence of CNS ischemia ($P > 0.05$). It should be emphasized that although diabetes is an important factor for the development of atherosclerotic lesions in arteries, in this material it did not increase directly the risk of cerebral stroke or TIA. The analysis of the incidence of neurological symptoms in patients treated for hyperlipidemia, compared to people without lipid disorders showed no statistically significant difference ($P > 0.05$), which allows to formulate a conclusion that fat metabolism disorders are not a direct risk factor for vascular cerebral incidents.

In some centers of cardiac and vascular surgery in the world, in patients with atherosclerosis of coronary and lower extremities' arteries

Tab. II. Characteristics of the analyzed group of patients in relation to the presence of neurological symptoms and carotid artery stenosis.

CAROTID ARTERY CHARACTERISTICS	WITH SYMPTOMS		WITHOUT SYMPTOMS		CHI ²	
	N	%	N	%		
Without carotid lesions	20	33.3	310	33.0	0.003	
Presence of all carotid lesions	40	66.7	630	67.0		
Presence of carotid lesions	stenosis of <50%	21	35.0	411	43.7	2.665
	stenosis of 50–69%	15	25.0	118	12.6	7.581
	stenosis of 70–99%	13	21.7	49	5.2	22.261
	Occlusions	11	18.3	52	5.5	15.662

Tab. III. Risk factors in patients with and without carotid artery stenosis.

GROUP CHARACTERISTICS	TOTAL		STENOTIC		NON-STENOTIC		STATISTICAL ANALYSIS
	N	%	N	%	N	%	
Mean age	62 ± 9.95		65 ± 11.2		61 ± 10.2		p > 0.05
Sample size	1000	100	670	67.0	330	33.0	
Sex							
Men	783	78.3	533	79.6	250	75.8	p > 0.05
Women	217	21.7	137	20.4	80	24.2	
Risk factors							
Smoking	710	71.0	442	66.0	268	81.2	p < 0.005
Hypertension	270	27.0	166	24.8	104	31.5	p < 0.05
Hyperlipidemia	51	5.1	31	4.6	20	6.1	p > 0.05
Diabetes	108	10.8	73	10.9	35	10.6	p > 0.05
IHD	142	14.2	109	16.3	33	10.0	p < 0.005

or pathological lesions in the abdominal aorta, preoperative examination of the carotid arteries is performed routinely [40, 53–57]. This reduced the risk of perioperative ischemic strokes [55, 58]. It was estimated that only 15 to 20% of patients undergoing cardiac surgery had an ultrasonographic Doppler examination of the carotid arteries [59]. The role of screening in the detection of carotid artery stenosis in preventing stroke is a constant subject of debate in the environment of neurologists and other physicians involved in the treatment of cerebral stroke [27–33]. Some researchers deny the necessity of screening for detection of carotid artery stenosis, justifying such an opinion with a relatively low incidence of this pathology in the general population and a low risk of cerebral stroke in asymptomatic patients [60]. Determination of the population in which certain risk factors or concomitant diseases could increase the likelihood of carotid atherosclerosis appears to be possible and desirable [26, 29, 37, 61]. Three groups of symptomatic patients, who should be subject to an examination of carotid arteries were identified, because they may be potential candidates for CA endarterectomy. These are patients with a history of an episode of transient ischemic attack, cerebral stroke or transient AF [41–43]. However, in asymptomatic patient's carotid artery examination is rarely performed, and usually in patients with known vascular murmur of the carotid arteries and in patients before major operations [44–47, 49, 53]. Patients who are supposed to undergo major surgeries, especially cardio-thoracic and vascular ones, should undergo screening. Especially, in case of the presence of atherosclerosis risk factors such as age above 50 years, hypertension, diabetes, cigarette smoking, ischemic heart disease and PAD. Preoperative tests of carotid arteries are advisable among them, since during major surgeries, especial-

ly cardio-thoracic ones, they are particularly vulnerable to an intraoperative decrease in cerebral blood flow below the critical value (i.e. <15 mL / 100 g / min) and to an ischemic stroke [40, 53, 61–65]. In the present study, it was proved that patients with peripheral artery disease constitute a group at high-risk of atherosclerotic lesions in extracranial carotid sections, causing stenosis of high degree. In this group of patient's special attention should be paid to individuals with a history of cerebrovascular incident as a high degree of stenosis in CA was detected in every fourth such patient.

CONCLUSIONS

1. Atherosclerotic lesions in the extracranial carotid sections, including a high-degree stenosis, occur with a high frequency among patients with atherosclerosis of peripheral arteries;
2. Statistically significant differences in the incidence and severity of atherosclerotic lesions in the carotid arteries were observed in the group of asymptomatic and symptomatic patients with a history of cerebral vascular ischemic episode;
3. A statistically significant relationship was revealed between the prevalence and severity of atherosclerosis in the carotid arteries in symptomatic patients and smoking and hypertension;
4. Screening in patients with atherosclerosis of the abdominal aorta and/or lower limb arteries may detect a significant carotid artery stenosis, requiring surgical treatment.

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