Efficacy of the Carotid Endarterectomy in Asymptomatic and Symptomatic Carotid Stenosis and in Patients with Multifocal Atherosclerosis

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Key words: Carotid endarterectomy; chronic arterial insufficiency; ischemic heart disease; Colour Duplex; Transcranial Doppler sonography.

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Abstract

Aim. The aim of the research was to study the effect of carotid endarterectomy (CEA) at patients with asymptomatic and symptomatic carotid stenosis, also in the patients with multifocal atherosclerosis (MFA): carotid stenosis in patients with peripheral arterial disease (PAD) of the limbs and ischemic heart disease (IHD).

Material and methods. Colour Duplex Doppler was used for screening of carotid pathology in 1104 patients with PAD, IHD, transitory ischemic attacks and an ischemic stroke. The group of 205 patients who had stenosis of a. carotis interna >60%, were divided into three subgroups – patients with asymptomatic carotid stenosis (ACS), patients with symptomatic carotid stenosis (SCS) and patients with multifocal atherosclerosis MFA.

Results. All 205 patients were subjected to CEA, conducted by a patch or shunt, which was successful performed at 201 patients (98%). Significant improvement of hemodynamic of the regional carotid as well as intracranial arteries on the side of the surgery was determined using Colour Duplex and Transcranial Doppler Sonography (TDS). At a second stage, after the successful CEA, a vascular reconstruction was carried out or an aorto-coronary bypass created in the case of patients with MFA.

Conclusion. CEA in the case of patients with asymptomatic and symptomatic carotid stenosis and a concurrent MFA is an efficient curative method of removing the carotid pathology with a minimum percentage of vascular complications.

Introduction

The brain stroke is a socially consequential condition, because it ranks third among the commonest reasons for death in the world after heart attack and cancer. Bulgaria is amongst the countries in Europe with the highest incidence of both, stroke and the exitus from it (1, 2). The most probable reason for this is the sum of total number of risk factors such as arterial hypotension, smoking, unhealthy diet and stress. These are risk factors that are conducive to the occurrence of arteriosclerosis, which affects the extra-cranial and intra-cranial blood vessels, bringing a brain stroke – thrombo-plastic or embolic. Over 80% of the strokes are ischemic. The stenotic and thrombotic processes in the carotid arteries cause nearly 1/3 of the brain strokes. Up to 20-30 % of those who have undergone an ischemic stroke die during the first year of their condition. Another 30% of them remain perma-
nently disabled. In the USA about 500 000 people undergo a stroke and 150 000 of them die. The total cost of the diagnosing and treatment of stroke and the ensuing complications in the country is 45 billion dollars (3-6).

Ischemic stroke leads to serious medical complications, even if it does not result in death, and it causes permanent damages which are difficult and expensive to treat, thus it is very important to have early diagnosing and prophylaxis of ischemic stroke. The early diagnosing of the carotid stenosis using Color Duplex Screening (CDS) allows us to conduct prophylaxis of stroke through treating the risk factors, using adequate medications, carotid surgery and endovascular stenting.

During the last few decades a number of large-scale multi-centre researches have proven the positive prophylactic effect of carotid endarterectomy (CEA) in the cases of asymptomatic and symptomatic carotid stenosis (7-12). In the cases of carotid stenosis, over 60-70% of patients had a considerable reduction of the risk for stroke after CEA, compared to patients treated with medication within a 2-3-year period (13-19). It is still uncertain what is the effect of CEA in the case of stenosis in asymptomatic and symptomatic patients (20-27).

Another disputable issue is the tactics should be used concerning the cases where carotid pathology is combined with other forms of multifocal atherosclerosis (MFA) e.g. cases of peripheral arterial disease (PAD) and ischemic heart disease (IHD) (28-30). An other doubt concerns the timing of the CEA: before, during or after the coronary or peripheral artery operation. There is also some arguments concerning the technology of CEA – should it be made with a shunt or without, with a patch of the carotid artery or without? Disputable issue is also the use of complications-entailing invasive carotidography; should only Color Duplex, MRI angiography or CT be performed.

All these disputable issues motivated us to conduct the current research which aim was to study the effect of carotid endarterectomy (CEA) in the case of patients with asymptomatic and symptomatic carotid stenoses, as well as in patients with combined multifocal atherosclerosis (MFA); to register the early results from surgery and to develop a tactics for treating patients with MFA concerning the sequence of steps in operative treatment; to develop a diagnostic and therapeutic method of conducting the treatment of patients with carotid stenosis (CS).

Materials and methods

Patients and groups

In the period of years 2005 – 2008, a 1104 patients have been admitted to the National Hospital of Cardiology, Department of Vascular Surgery and Angiology, for examination with Color Duplex. The most of them had a peripheral arterial disease (1013 patients, men 72.2% and women 27.7%, with average age of 63.7 years ± 11.4); some of them had a strong or chronic arterial insufficiency (890 patients, or 87.8%), while 123 patients (12.1%) had arterial aneurysms. All patients underwent a screening investigation for carotid pathology by CDS. A group of 205 patients with carotid stenosis exceeding 60% was selected, who were eligible for CEA, with average age 63.2 years +/- 8.4 and sex distribution of 170 men (83%) and 35 women (17%). Among them 114 patients had additional PAD (including 9 patients with aneurysm of the abdominal aorta and 44 patients with concomitant IHD) and the rest 91 patients with IHD and transitory ischemic attack (TIA) or stroke.

For the purpose of the study, the patients were divided into groups regarding the symptomatology/asymptomatology and regarding to the concomitant MFA.

A group of 101 patients with asymptomatic carotid stenosis (ACS) - these were patients without anamnesis and clinical tests for TIA or stroke on the side of the critical stenosis.

A group of 104 patients with symptomatic carotid stenosis (SCS) – these were patients who had undergone TIA or stroke on the side of the critical stenosis.

A group of patients with MFA – patients with carotid stenosis and a concomitant other form of atherosclerosis, who were subdivided in the following three subgroups: 114 patients with CS and PAD; 84 patients with CS and IHD; 44 patients with CS, PAD and IHD.

Diagnostic procedures

The screening and the preoperative diagnosing of the patients was separately carried out with Color Duplex by two independent echographers. Using B-mode, Color Doppler and PW Doppler, those parameters were defined: the degree of stenosis of common carotid artery (CCA) and internal carotid artery (ICA), the character of the plaque(s), the maximum systolic and diastolic velocity of blood circulation in the area of the stenosis. All the patients simultaneously were...
examined for the presence of stenosis on the contralateral carotid arteries and doppler-sonographic examination of the peripheral arteries by ankle-brachial index (ABI).

In 184 out of 205 patients (89.7%) beside CDS, a Transcranial Doppler Sonography (TDS) was performed. The blood circulation in middle cerebral arteries (MCA), anterior cerebral arteries (ACA) and posterior cerebral arteries (PCA) was examined. Also, the condition of the brain blood circulation distally from the stenosis (thrombosis) was conducted too.

Carotidography was conducted in 27 patients (13.1%) who had MFA, 18 of them by one-moment coronaryography and carotidography and another 9 patients one-moment peripheral and carotid angiography was conducted.

Peripheral aorto-arteriography of 93 patients with PAD and CS (45.3%) was carried out.

By pictorial diagnosing 107 patients (52.1%) were examined, 21 using MRI and 86 using NO.

**Surgical procedures**

All of 205 patients with screened critical stenosis, under general anesthesia, were subjected to one-side carotid endarterectomy - CEA. Standard operative technique – endarterectomy was employed, following the preliminary implanting of a shunt between CCA and the distal part of ICA. In all patients a patch of carotis interna was made in the place of the removed stenosis. Its aim was to distend the diameter of the artery and to prevent an early or later restenosis.

Postoperatively the patients were examined again by CDS and TDS (in some of them) so the regional and general brain haemodynamics were studied. In the part of the high-risk patients intraoperative monitoring of the blood circulation of MCA was conducted by TDS.

**Statistical analysis**

At patients with clinical data for vascular-neurological complications, postoperative diagnosing using Color Duplex, TDS and CT was conducted.

The data from the study were statistically processed by different methods: variation and correlation analysis, as well as by examination of the relative risk, studying the RR and the Odds ratio.

**Results**

The patients with CS >60% from the different groups were examined regarding incidence of risk factors for atherosclerosis (Table 1).

<table>
<thead>
<tr>
<th>Patients with CS &gt;60%</th>
<th>HTA n (%)</th>
<th>Diabetes n (%)</th>
<th>Smoking n (%)</th>
<th>Dyslipidemia n (%)</th>
<th>Number of risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS (101 pts)</td>
<td>95 (94)</td>
<td>49 (48)</td>
<td>82 (81)</td>
<td>77 (76)</td>
<td>3</td>
</tr>
<tr>
<td>SCS (104 pts)</td>
<td>103 (99)</td>
<td>38 (36)</td>
<td>83 (79)</td>
<td>82 (78)</td>
<td>2.9</td>
</tr>
<tr>
<td>Total (205 pts)</td>
<td>198 (96)</td>
<td>87 (42)</td>
<td>105 (80)</td>
<td>159 (77)</td>
<td>3</td>
</tr>
<tr>
<td>MFA (44 pts)</td>
<td>44 (100)</td>
<td>27 (61)*</td>
<td>44 (100)*</td>
<td>43 (97)*</td>
<td>3.5 *</td>
</tr>
<tr>
<td>Odds Ratio CS:MFA</td>
<td>1.5</td>
<td>2.1</td>
<td>10.6</td>
<td>12.4</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: Risk factors in patients afflicted with carotid atherosclerosis.**

CS – Carotid stenosis; ACS – Asymptomatic carotid stenosis; SCS – Symptomatic carotid stenosis; MFA – Multifocal atherosclerosis; HTA – Hypertension arterialis; *p<0.05.

The high frequency of the risk factors is quite impressive: hypertension arterialis (HTA), diabetes, smoking and dyslipidemia. The average number of risk factors (out of the enumerated above) was 3, excluding the group of patients with MFA (who had a combination of CS, PAD and IHD) in which the frequency of the risk factors was higher. In this group the Odds ratio or the chance of those having CS to develop MFA was: 2.1 (CI 95% 1.1-4.1) for diabetes, 10.6 (CI 95% 1.4-79) for smoking, 12.4 (CI 95% 1.6-92) for dyslipidemia and 1.5 (CI 95% 1.1-19) for arterial hypertonia. The high frequency of the risk factors is indicative of being direct correlation between them and the process of atherosclerosis, this correlation was even more evident in MFA.

In 104 patients with SCS a comorbidity of stroke was at 81 patient (77.8%) and transitory ischemic attack (TIA) at 42 (40.3%). At those patients quite impressive was the high frequency of stroke on the ipsilateral side of SCS at 62 (59.6%) patients, as well as the relatively high frequency of strokes that took place counter-laterally 19 (18.2%).

Among the subgroup of 114 patients with MFA (CS plus PAD), they mainly belong in the second stage of the illness (claudicatio intermittence) – 102 (89.4%), while 1 (0.9%) was in stage I, 6 (5.2%) in stage III and 5 (4.3%) in stage IV. The average value of ABI for the group was 0.62±0.26 and was significantly lower (p<0.05*) compared to the subgroup with MFA (CS plus IHD).

In the subgroup of 84 patients with MFA (CS plus IHD) a great part of the patients had a stenocardia – 20 (23.7%), heart attack – 29 (34.5%), aorto-coron...
nary bypass (ACB) with stenocardia – 14 (16.6%), ACB without stenocardia – 6 (7.1%), while 7 of them (8.3%) had stent with stenocardia and 8 (9.5%) had stent without stenocardia. These facts are indicative of the developed process of atherosclerosis in the coronary arteries combined with carotid arteriosclerosis.

Using the average values of ABI in the different groups with CS (ACS, SCS, MFA), a pathological index was determined under 0.9 and it was 0.74 ± 0.28 at ACS, 0.86 ± 0.23 at SCS, 0.62* ± 0.26 at MFA-PAD, 0.71* ± 0.27 at MFA-IHD and 0.60* ± 0.25 at MFA-PAD-IHD. Average ABI for all CS was 0.8 ± 0.25 and it was significantly different (p < 0.01*) in the subgroups with MFA. This is a result of the fact that atherosclerosis is a multifunctional process, which affects simultaneously both the peripheral arteries and the carotid and coronary ones. ABI can be used as a marker for MFA.

By Color Duplex the frequency and percentage of CS in the different groups of patients was determined (Table 2).

Table 2: Frequency and percentage of the CS in the different groups of patients.

<table>
<thead>
<tr>
<th></th>
<th>CS = 60-69% n (%)</th>
<th>CS = 70-79% n (%)</th>
<th>CS = 80-89% n (%)</th>
<th>CS &gt; 95% n (%)</th>
<th>Two-side carotid pathology n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS</td>
<td>7 (6.9)</td>
<td>44 (43.5)</td>
<td>26 (25.7)</td>
<td>24 (23.7)</td>
<td>63 (62.3)</td>
</tr>
<tr>
<td>SCS</td>
<td>11 (10.5)</td>
<td>27 (25.9)</td>
<td>25 (24)</td>
<td>41 (39.4)</td>
<td>66 (63.4)</td>
</tr>
<tr>
<td>MFA-PAD</td>
<td>8 (7)</td>
<td>39 (34.2)</td>
<td>29 (25.4)</td>
<td>38 (33.3)</td>
<td>77 (70.5)</td>
</tr>
<tr>
<td>MFA-IHD</td>
<td>5 (5.9)</td>
<td>23 (27.3)</td>
<td>22 (26.1)</td>
<td>34 (40.4)*</td>
<td>51 (60.7)</td>
</tr>
<tr>
<td>Total</td>
<td>18 (8.7)</td>
<td>71 (34.6)</td>
<td>51 (24.8)</td>
<td>65 (31.8)</td>
<td>62.9%</td>
</tr>
</tbody>
</table>

ACS – Asymptomatic carotid stenosis; SCS – Symptomatic carotid stenosis; MFA – Multifocal atherosclerosis with Peripheral Arterial Disease; MFA-IHD – Multifocal atherosclerosis with Ischemic Heart Disease; *p < 0.05.

The average percentage of CS was 81.0%. The highest percentage of stenosis >90% was found at 31.8% of patients, especially in the group of patients with SCS and MFA-IHD, where this percentage reached 40%. The frequency of carotid stenosis >90% was considerably higher in the group of patients with SCS compared to the group of patients with ACS (Odds ratio = 5.9). This explains the fact of symptomaticity of the process that goes along with the increasing of the percentage of stenosis. Critical stenosis >80% had over 56% of the patients and these facts are indicative for the weight of the carotid pathology. These patients had a high risk of developing an ischemic stroke.

The advanced character of the process of atherosclerosis was also determined by establishing the two-side character of the process, which is characteristic at 30% of the cases, for stenosis >50% (Table 3.). In 10% the patients that underwent operation contralateral thromboses were established. In 9% of the patients critical stenosis >70% were found, and this process was more evident in patients with SCS (Odds ratio = 3.09; RR = 2.8). The two-side pathology established heightens the risk of complications during CEA. On the other side, the risk of stroke in non-operated patients is much higher compared to the risk of complications. This makes the balance between advantage and risk type in favor of the operation.

Table 3: Frequency and percentage of contralateral pathology of a. carotis in ACS, SCS and the total of them.

<table>
<thead>
<tr>
<th>Contralateral carotid stenosis</th>
<th>CS = 50-70%</th>
<th>CS &gt; 70%</th>
<th>Thromboses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS (101 patients)</td>
<td>6 (5.9%)</td>
<td>5 (4.9%)</td>
<td>5 (4.9%)</td>
</tr>
<tr>
<td>SCS (104 patients)</td>
<td>19 (18.2%)</td>
<td>14 (13.4%)</td>
<td>17 (16.3%)</td>
</tr>
<tr>
<td>Total (205 patients)</td>
<td>24 (11.7%)</td>
<td>19 (9.2%)</td>
<td>22 (10.7%)</td>
</tr>
<tr>
<td>Odds ratio / CI95%</td>
<td>3.54 / 1.35-9.27</td>
<td>3.09 / 1.06-8.9</td>
<td>3.75 / 1.33-10.6</td>
</tr>
<tr>
<td>Relative risk / CI95%</td>
<td>1.61 / 1.22-2.1</td>
<td>2.8 / 1.04-7.48</td>
<td>1.62 / 1.23-2.13</td>
</tr>
</tbody>
</table>

ACS – Asymptomatic carotid stenosis; SCS – Symptomatic carotid stenosis.

Using the B-mode the character of the carotid plaque was determined. In 11.2% of the patients with CS, a plaque of type I was established (Gray-Weale plaque scores), while in 78% of the stenosis plaque of type II was found. Both types of plaque are hypoechoic, with a high-risk of embolism or thrombosis, because they consist of a lipid nucleus and hemorrhages in them. This is indicative fact that the patients going endarterectomy have a the high-risk of having vascular and neurological complications. Plaques type III and IV were found at 10.7% of the patients with CS.

Using the Color Duplex/PW Doppler, the velocity of the blood was measured in the area of the stenosis to be subjected to CEA. The maximum systolic velocity was 236 ± 81 cm/s, while the diastolic velocity was 82 ± 42 cm/s (normal = below 125 cm/s for systolic velocity). This pathological velocity exceeds many times the normal value and reflects the gravity of the process. A reliable correlation was determined between the degree of stenosis and the velocity of the blood r = 0.75, this being a pretty strong correlation.

In 184 patients preoperative examination using TDS was carried out. In the rest of cases no echographic window was found (Table 4).

A moderate reduction in the intracranial brain blood circulation was ascertained – reduction of the
maximum systolic velocity of MCA and ACB on the side of the CEA, compared to the counter-lateral side ($p<0.001^*$).

In all 205 patients with carotid stenosis CEA was conducted by shunt and patch plastic. The starting diagnosis arrived by CDS was fully (100%) confirmed by the intraoperative diagnosis.

In part of the high-risk patients intraoperative monitoring of the blood circulation of MCA was conducted by TDS. This examination gave us important information concerning the brain hemodynamic during the clamping of the artery, concerning the efficiency of the shunt implanted, as well as concerning the presence of distal embolisms – aerial or organic microembolisms. The implementation of intraoperative monitoring using TDS is necessary mainly when the indications for implanting of a shunt are determined, but in our cases a shunt was implanted in all of them and the employment of TDS was restricted.

In 201 patients (98%) of CEA treated patients, the intervention was successful and the patients had left the hospital on the third day after the surgery.

All patients with CEA were examined postoperatively using Color Duplex. In 203 of them a removal of the carotid stenosis was ascertained. The regional hemodynamic was found to be already normal – the blood velocity in ICA was corrected under 100 cm/s.

Postoperatively a part of the patients were examined by TCD, so an evaluation of the brain hemodynamic following CEA was made and possible complications – ischemic stroke or hyperperfusion syndrome was ascertained (Table 4). A reliable increase ($p < 0.001^*$) of the blood circulation of MCA, ACA and PCA was established on the side of the operation in all groups.

All patients with vascular-neurological complications were examined postoperatively by CT and the diagnosis of ischemic stroke was confirmed in 4 patients. Postoperative stroke developed probably caused by an embolic accident or bad compensation during the clamping of the artery, especially in cases where the plaque was of type I or II. Only in one of the cases contra-lateral thrombosis occurred. One patient from the group of ACS developed ischemic brain stroke with rethrombosis of ICA, but he has a 90% stenosis, plaque of type I, with a distinctive MFA – combined PAD and IHD (the patient had suffered ACB). In one patient of the same group TIA developed due to an embolic accident. In one of the patients from the group with SCS postoperative hematoma developed which entailed a revision of the operative wound.

Studying the reasons for the early complications following CEA, it was established that the risk of stroke in the symptomatic stenosis is three times higher compared to the risk of stroke in asymptomatic stenosis (RR = 3.1). In CS>90% of the relative risk of development of a postoperative stroke is 6.4 (CI 95%: 0.6-60); for plaque of type I RR = 7.9 (CI 95%; 1.1-5.3); for contra lateral thrombosis RR is 2.7 (CI 95%: 0.3-25); for a recent (up to a month earlier) stroke RR is 9.4 (CI 95%: 1.1-79); for combined MFA (CS, PAD and IHD) RR is 2.9 (CI 95%: 0.3-28). All these factors increase many time the risk of development of stroke after the CEA and must be carried in mind when an operation is planned or in the early postoperative period. Those risks are not contraindicating of CEA, because the frequency of complications is relatively low in comparation to the benefit from CEA.

### Table 4: TDS parameters of the blood circulation in the intracranial brain arteries before and after CEA in a total of 184 patients with ACS and SCS.

<table>
<thead>
<tr>
<th>TDS V max cm/s</th>
<th>Total before CEA</th>
<th>On the side of CEA</th>
<th>On the counter-lateral side</th>
<th>Total after CEA</th>
<th>On the side of CEA</th>
<th>On the counter-lateral side</th>
<th>Increase % total</th>
<th>Increase % on the side of CEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCA total</td>
<td>76.4 ±21</td>
<td>66.2* ±18</td>
<td>86.1 ±17</td>
<td>81.7 ±20</td>
<td>85.6* ±25</td>
<td>81.3 ±20</td>
<td>6.9% ±16</td>
<td>29.3% ±25</td>
</tr>
<tr>
<td>MCA (in ACS)</td>
<td>81.1 ±18</td>
<td>77.3* ±19</td>
<td>89.9 ±18</td>
<td>86.3 ±20</td>
<td>96.2* ±22</td>
<td>84.3 ±19</td>
<td>6.4% ±16</td>
<td>26.5% ±24</td>
</tr>
<tr>
<td>MCA (in SCS)</td>
<td>71.8 ±17</td>
<td>61.1* ±17</td>
<td>82.3 ±17</td>
<td>78.1 ±16</td>
<td>81* ±17</td>
<td>75.2 ±16</td>
<td>8.7% ±16</td>
<td>32.5% ±25</td>
</tr>
<tr>
<td>ACA Total</td>
<td>66.1 ±17</td>
<td>57.2* ±16</td>
<td>74.8 ±17</td>
<td>69.8 ±16</td>
<td>74.1* ±17</td>
<td>68.5 ±16</td>
<td>5.5% ±16</td>
<td>29.5% ±25</td>
</tr>
<tr>
<td>PCA Total</td>
<td>46.8 ±11</td>
<td>42.8* ±9</td>
<td>52.0 ±10</td>
<td>50.2 ±9</td>
<td>54.8* ±11</td>
<td>48.2 ±9</td>
<td>7.2% ±9</td>
<td>26% ±26</td>
</tr>
</tbody>
</table>

TDS – Transcranial Doppler Sonography; CEA – carotid endarterectomy; MCA – middle cerebral arteries; ACA – anterior cerebral arteries; PCA - posterior cerebral arteries; *p<0.001.

Discussion

A period of 38 years has passed from the first multi-centre study of the effect from CEA – Joint Study of Extracranial Arterial Occlusion, carried out in 1970 (31). In this study the operation-related morbidity and death rate was up to of 35%. Twenty years later, one of the biggest multi-centre studies was carried out – the North American Symptomatic Carotid Endarterectomy Trial (NASCET) (19, 32) two year follow up was made within 658 patients with symptomatic carotid stenosis, where 328 of them were subjected to CEA and the rest were treated with medicaments. The early and late results from the study categorically showed...
that the efficiency and preventive effect from CEA in the cases of symptomatic carotid stenosis exceeded 70%. The cumulative risk of ischemic stroke within the two-year period was 9%, compared to 26% in the case of patients treated with medicaments. The early perioperative morbidity and death rate in CEA was only 5.8%. The study also ascertained better results from CEA in the case of stenosis 50 - 69%, even in those cases with recent strokes and contra lateral thromboses. The risk of development of a stroke within the two-year period was 69% if the patient was not subjected to an operation. The conclusion drawn up was that CEA reduced nearly three times the risk of occurrence of a stroke and death in the case of patients with SCS. Another big multi-centre study looking into the effect from CEA—the European Carotid Surgery Trial (ECST) (11, 33) was published in 1991. The average period within the patients were followed up was 2.7 years. The frequency of the perioperative stroke and exitus was 7.5%, the cumulative percentage of stroke and death in the case of CEA was 12.3%, compared to 21.9% in the case of the group of patients treated with medications. The study draws the conclusion that an absolute indication of the need of CEA is an ACS exceeding 80%. Another multi-centre study – the Asymptomatic Carotid Atherosclerosis Study (ACAS) (7), involving the research of a total of 662 patients with stenosis exceeding 60% - ascertains that CEA reduces over two times the frequency of ischemic stroke and death within a 2.7-year period.

The European Initiative for Brain Stroke (EUSI) recommends the conduction of CEA in symptomatic stenosis exceeding 70%, when there is no significant neurological deficit and only in those centers where the periopartive risk of insult and dead is bellow 6%. In the case of stenosis between 50 and 79% CEA can be conducted when there is no grave neurological deficit and only in centers where the perioperative frequency of stroke and dead is bellow 3%.

Our research was studying the effect from CEA in the treatment of asymptomatic and symptomatic carotid stenosis exceeding 60% corroborates the positive effect from the operation. The critical carotid stenosis was removed in 98% of the cases, the percentage of complications was only 2%. This makes our center one with very good operative results, meeting the world standards. Hence, our ability to determine the following indicators makes possible the conduction of CEA in symptomatic and asymptomatic stenosis exceeding 70%, in the patients without significant neurological deficit, where the condition for the centers is under 6% peri and postoperative complications. Also, as a center with perioperative complications under 3% we meet the needs for treatment of stenosis from 60 to 69% in the case of unstable plaque of type I; a recent milder ipsilateral stroke, presence of contra lateral thrombosis; concomitant MFA – IHD and PAD.

According our experience we have determined the risk factors for the development of a perioperative stroke: stenosis over 90%, plaque of type ², contra lateral thrombosis, a recent stroke and the presence of MFA were partly corroborated by the conclusions other authors arrived.

Concerning the tactics employed in conducting CEA in the case of patients with MFA, we embraced and applied the idea that the carotid operation must precede the coronary operation or the vascular reconstruction. A number of studies prove the high frequency of strokes in the case of ACB or even in the case of a peripheral vascular operation, when the medium carotid stenosis are over 50% (29, 33). Thus in ACB and with a concomitant CS, the risk of stroke is up to 3.8%, in the case of bilateral stenosis – 5%. Identical results are reported in the case of patients with CS, operated in the aorto-iliac segment – up to 13% perioperative stroke (30). This makes necessary the conduction CEA before or after the vascular reconstruction (ACB). Most studies establish a high frequency of perioperative complications in the case of combined CEA/ACB. The meta-analysis of 56 studies establishes the following frequency of perioperative strokes: when ACB precedes CEA – 10%, in combined CEA/ACB - 6%, in CEA preceding ACB – 5%. Irrespective of these facts, some centers (including our) carry out this risky combined operation. For instance, out of 68 combined operations in a Bulgarian centre 11.7% are reported to have entailed complications – perioperative death and strokes (34). The world expert groups at the moment have it that it is acceptable to carry out combined operations CEA/ACB only in centers in which the perioperative strokes and death are under 3% for the two operations conducted simultaneously (35). It is our opinion that this restriction does not solve the problem. It is well known that during ACB (with pump) the brain microcirculation suffers considerably, as a result of which 20 up to 40% of the patients have a durable deterioration of the mental capacity (36). When CEA is carried out immediately before ACB, the brain microcirculation suffers from periods of hypoxia, micro embolisms and disturbed rheology, as well as from hyper perfusion with a predisposition to brain edema immediately after the revascularization. A combined operation would expose the patient to a considerable risk from a brain damage even when there is no realized brain attack. This is the reason for us to apply...
the following tactics – CEA before ACB or vascular reconstruction and we had no complications. It is possible that could be separate cases of unstable stenocardia or stenocardia III-IV, when ACB is urgent and a preceding CEA – highly risky. In such cases the more adequate decision would be to carry out carotid stenting (with protection) immediately before ACB. Endovascular therapy, even though not showing identical results with CEA, shows similar results (37) and as far as the cases in point are concerned, the different studies show that stenting has precedence before the operative method (38). In the cases when we have indications allowing the accomplishing of peripheral vascular reconstruction, we make CEA first and then the peripheral operation. The delay of few days had no negative effect on the vascular reconstruction and does not pose any risk of losing a limb because of the delay. In the present study after CEA, at a second stage, successful vascular reconstruction was carried out in 89 patients with CAIL and in 12 patients with ACB and we had no vascular-neurological complications whatsoever.

In a number of centers Color Duplex is already used (29), with or without MRI, for preoperative diagnosing of carotid stenosis. This is due to the fact that the non-invasive methods are already highly sensitive and with a great specificity and on the other hand, that the carotidography has 1-2% chance of causing stroke in these risk patients. The system of independent diagnosing we introduced involving two echographs and combining the Color Duplex with TDS, allows us to carry out operations only on the basis of data from these diagnostic methods. CDS is safe, reliable, non-invasive and cheap method, giving us precious information about the degree of the stenosis, the character of the plaque and the condition of the carotid hemodynamic. Within an intraoperative comparison a high (100%) diagnostic reliability of the method was determined. In separate cases – when the echographic finding is uncertain – the same investigation can be carried out by contrast study employing MRI or CT. We could not find in the literature other comprehensive application than TDS, for investigating the brain blood circulation – before, during and after CEA. TDS is mainly used for inoperative monitoring and when the indications for the implanting of shunt are studied. We employed the method for a complex evaluation of the brain hemodynamic at all stages of the research, this allowing us to obtain valuable information concerning the operative risks, the effect from CEA and the complications occurring. TDS and Color Duplex should be considered indispensable diagnostic procedures before and after CEA.

Conclusions. On the basis of the results obtained and the analysis conducted, the following major conclusions can be made:

CEA is an efficient way of treatment of the carotid stenosis, its early positive effect being established in 98% of the cases, a perioperative stroke occurring in only 1.95% of the cases.

A relatively high frequency of carotid stenosis >60% was ascertained in the case of patients with PAD and IHD. A high frequency of carotid stenosis >60% was ascertained in the case of patients with the combined forms – concomitant PAD – 55%, concomitant IHD - 40%, a combination of the two - 21%. The stenosis was discovered by CDS. The results corroborate the finding that atherosclerosis is a multifocal affair.

The following major risk factors for carotid and multifocal atherosclerosis were established: arterial hypertonia, diabetes, smoking, dyslipidemia, belonging to the male gender (correlation between men and women – 5:1), more than three of the aforementioned factors being present in MFA. The risk (Odds ratio) in the case of patients with CS of developing MFA is as follows: for dyslipidemia - 12.4, for smoking – 10.6, for diabetes - 2.1, and for arterial hypertonia – 1.5.

CDS is a method making possible the conduction of a non-invasive screening of carotid stenosis and can be used as an independent pre-operative method for determining the indications of CEA. It can also be a method for conducting post-operative control. The results from pre-operative diagnosis by Color Duplex and intro-operative finding corroborated each other.

Pre-operative diagnosing employing TDS gives us valuable information about the condition of the brain hemodynamic as well as about the presence of distal stenosis. TDS should be made an obligatory diagnostic method in CEA.

The operative technique employing shunt provides better opportunities for surgery of the high-risk patients with critical stenosis and contra lateral stenosis, as well of patients who had recently had a brain stroke. No hyper-perfusion syndrome is observed when this technique is applied.

The following risk factors for the development of a perioperative stroke when applying CEA were ascertained: stenosis exceeding 90%, unstable plaque of type I, counter-lateral thrombosis, a recent stroke, MFA- PAD and IHD.

TDS was applied intra and postoperatively, this having led to an intensification of the brain blood
circulation on the side the operation took place in.

Indicators for CEA were worked out: symptomatic and asymptomatic carotid stenosis >70%; carotid stenosis >60% with concomitant counter-lateral thromboses or MFA, for centers in which perioperative stroke is beneath 3%.

Based on the experience accumulated a tactics for therapeutic behavior in the case of patients with critical carotid stenosis and MFA was worked out. CEA is the first stage of treatment, the second stage involving ACB or peripheral vascular reconstruction. In cases when ACB is urgent, pre-operative carotid stenting with protection is required.

Patients who underwent aortal-iliac reconstruction and ACB were operated within the second stage with no ensuing complications.

References


