Original article

Early and late outcomes of percutaneous transluminal angioplasty of cephalad arteries

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Abstract

Background: Efficacy of carotid endarterectomy (CEA) in prevention of stroke in patients with carotid artery stenosis has been confirmed in randomised trials. Carotid artery stenting (CAS) is a routine clinical practice and recent results of CAS are not worse than CEA. Moreover, percutaneous transluminal angioplasty (PTA) techniques allow other cephalad arteries to be dilated.

Aim: To assess early and long-term outcome of PTA of cephalad arteries and to determine risk factors of early and late major adverse cardiovascular and cerebral events (MACCE).

Methods: The study group consisted of 223 consecutive patients (151 males, 67.7%, mean age 65.3±8.6) in whom 256 PTA procedures of cephalad arteries were performed. Two hundred and forty-two internal carotid, 7 common carotid and 15 vertebral arteries were dilated. Thirty-four patients underwent one-stage carotid and coronary procedures, while in 46 patients one-stage carotid and peripheral procedures were performed. Neuroprotection with a distal protection device was used in 51.5% of cases. The procedures were divided into two groups: with high (n=181) and low (n=75) risk of cardiovascular events. Early and late events were recorded and analysed subsequently.

Results: In hospital 30-day MACCE occured in 12 (4.6%) patients, including 7 (2.7%) strokes, 3 (1.1%) myocardial infarctions and two (0.8%) deaths. Transient ischaemic attacks were observed in 8 patients, pulmonary oedema in 3 cases, as well as a single episode of retinal artery embolisation and acute renal insufficiency. The incidence of 30-day MACCE was not significantly higher in the high-risk group (6.07 vs. 1.33%; NS), but the risk of any adverse event was significantly higher (p=0.03). There was no difference in stroke incidence between procedures with or without neuroprotection (2.27 vs. 3.22%; NS). There was no difference in risk of MACCE between angioplasty of cephalad artery and one-stage cephalad and coronary artery angioplasty procedure (3.6 vs. 5.5%; NS). During 50.3±20 months of follow-up there were 16 (7.1%) deaths, 9 (3.5%) strokes and 6 (2.3%) restenoses confirmed angiographically. One-year total survival and one-year MACCE-free survival rates according to the Kaplan-Meier analysis were 94.9% and 89.0%, showing a trend towards better outcome in the low-risk group (F-Cox=2.46; p=0.19 and F-Cox=2.17; p=0.09 respectively).

Conclusions: Percutaneous transluminal angioplasty of cephalad arteries is safe and feasible, with a low periprocedural complication rate and good late outcome. Carotid artery stenting is an alternative method to CEA.

Key words: percutaneous transluminal angioplasty of carotid arteries, carotid stenting, cephalad arteries

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Introduction

Stroke is currently the third most frequent cause of death and the major cause of permanent disability. Every year 1.5 million people in Europe and the United States suffer from stroke, and 30-40% of all cases are caused by atherosclerotic carotid artery disease [1].

The effectiveness of surgical carotid endarterectomy (CEA) in preventing stroke in patients with severe occlusion of carotid arteries was confirmed in randomised clinical trials (NASCET, ECST, ACAS) [2-4]. Along with the development of non-invasive techniques of percutaneous revascularisation of coronary arteries,

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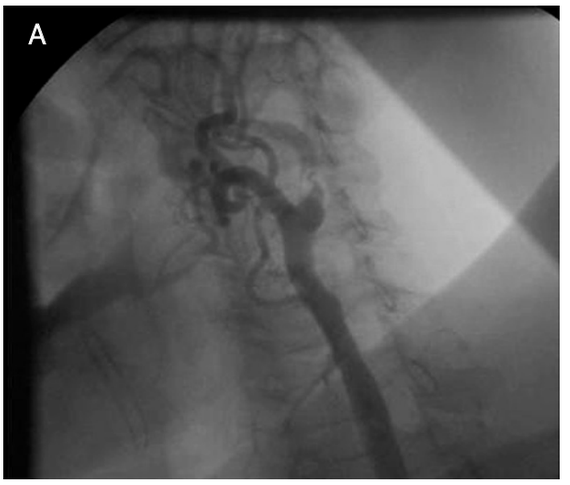

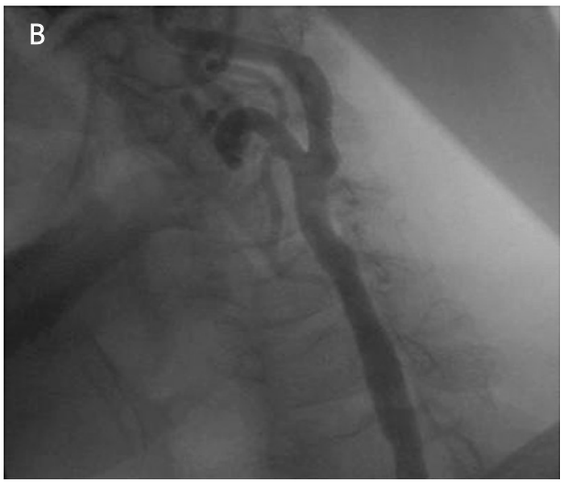

Figure 1. A. Angiogram of the left carotid artery. Critical stenosis in the proximal segment of the left internal carotid artery. **B.** Control angiography of the left carotid artery after CAS

Table I. Demographic data of the population and comorbidities

Parameter	Value
Mean age of patients [years]	65.3±8.6
Men [%]	67.7
Symptomatic patients [%]	37.6
Coronary artery disease [%]	92.8
Diabetes mellitus [%]	26.0
Hypertension [%]	69.5
Peripheral artery disease [%]	25.1
Dyslipidaemia [%]	54.22

Table II. Demographic data – low-risk and high--risk groups

Parameter	Groups		p
	high-risk	low-risk	
Number of procedures	181	75	
Mean age of patients [years]	65.6±8.6	64.2±8.1	NS
Men [%]	64.6	68.0	NS
Symptomatic patients [%]	50.8	6.7	0.001
Coronary artery disease [%]	95.6	89.3	NS
Diabetes mellitus [%]	24.3	32.0	NS
Hypertension [%]	71.8	62.6	NS
Peripheral artery disease [%]	22.1	37.3	0.018
Dyslipidaemia [%]	60.2	54.6	NS

attention was paid to the possibility of applying this method to the treatment of carotid and vertebral artery lesions (*percutaneous transluminal angioplasty*, PTA; *carotid stenting,* CAS). Results of early studies designed to assess the efficacy and safety of this method were disappointing and due to a high rate of periprocedural neurological complications the studies were discontinued [5, 6]. The progress that has been made in this field within the past few years, including the introduction of self-expanding stents, systems of neuroprotection as well as the increasing experience of invasive cardiologists, led to more frequent use of CAS in clinical practice, and its results are not inferior to those of CEA [7, 8]. Furthermore, the percutaneous techniques allow interventions on other cephalad arteries, e.g. vertebral arteries.

The aim of this study was to evaluate early and late outcomes of angioplasty of the cephalad arteries (PTA-CA) in our centre as well as the analysis of factors affecting the risk of cardio-cerebrovascular events in early and late follow-up (Figure 1).

Methods

Patients

This prospective analysis included 223 patients (151 men, 67.7%) at the mean age of 65.3±8.6 years, who underwent 256 procedures of PTA-CA between June 1997 and March 2005. The demographic characteristics of patients and their comorbidities are shown in Tables I and II.

Inclusion/exclusion criteria

The criteria to qualify for invasive treatment included the presence of asymptomatic stenosis of carotid or vertebral artery of >70% or stenosis of >50% in patients with a history of cerebrovascular events and/or critical stenosis of the contralateral carotid artery. Calcifications, tortuosity of the vessel, certain localisation of lesions, anomalies and atypical bifurcation of carotid arteries were not contraindications for CAS procedure. Patients were disqualified from the procedure only in case of total

occlusion of carotid/vertebral artery or absolute contraindications for double anti-platelet therapy (active gastrointestinal bleeding, recent haemorrhagic stroke, allergy to aspirin). In case of angiographic and ultrasonographic evidence of unstable atherosclerotic plaque containing clots, patients were pretreated with anti-platelet agents and anticoagulants (aspirin, ticlopidine/clopidogrel, low-molecular-weight heparin) for 2-4 weeks. Patients with angiographically proven critical stenosis of coronary or peripheral arteries (stenosis >90%) were selected for simultaneous angioplasty of these vessels.

Groups

In order to classify the procedures into high- or low-risk of adverse cardio-cerebrovascular events the empirical method was used and all procedures were divided into two groups: high-risk group (n=181) and low-risk group (n=75). The group of high-risk procedures included procedures in patients meeting at least one of the following criteria: documented ischaemic heart disease requiring immediate revascularisation, severe valvular disease, left ventricular ejection fraction <40%, bilateral carotid involvement, history of stroke or multiple recurrent transient ischaemic attacks (TIA) within one month prior to the procedure.

Techniques and definitions of the procedureal efficacy

The majority of the procedures involved access through the femoral artery. In case of advanced atherosclerosis of aorta or iliac and femoral arteries, the preferable access was through the brachial artery, using Sone's method. Using guide catheters (6-8 F) or long vascular sheaths (6-8 F, 90-110 cm), self-expanding stents were implanted into the stenosed carotid arteries. Pre-dilatation was performed only in case of critical stenosis (>90%) or when calcifications were seen under fluoroscopy, that could prohibit introduction and expansion of the stent. Balloon catheters of 3.5-6.0 mm diameter were used for the post-dilatation. In a number of patients distal cerebral protection with a vascular filter was used. Because distal protection systems were unavailable until 2002, before that date all carotid procedures were performed without neuroprotection. After 2002 at first only Angioguard filters were used, then new devices available in Poland were introduced (Filterwire, Accunet, Spider, Emboshield, etc.). Angioplasty procedures of vertebral arteries were carried out with direct stenting without distal protection. The procedure was considered successful when the stenotic segment of the carotid/vertebral artery was effectively dilated and a positive angiographic effect (residual stenosis <30% with adequate blood flow) was achieved.

Pharmacological treatment

In order to minimise the risk of thromboembolic complications, 3-5 days prior to the procedure dual anti-platelet therapy was initiated (aspirin 150 mg/24 h plus ticlopidine 500 mg/24 h or clopidogrel 75 mg/24 h). Routine hydration using 0.9% sterile saline solution was administered. Sedatives were not applied prior to the procedure to facilitate accurate neurological assessment during angioplasty. Throughout the procedure anti-sthrombotic agents were administered (UFH 100 IU/kg of body weight) to provide prolongation of ACT to 300-350 s. Two-to-three minutes prior to stent implantation 0.5-1.0 mg of atropine was injected intravenously to prevent bradycardia and haemodynamic instability. In case of profound hypotension infusion of inotropic agents was used (dopamine 5-15 μg/kg/min). After the procedure the anti-platelet therapy was continued (ticlopidine or clopidogrel for the first 4-6 weeks and aspirin indefinitely).

Myocardial revascularisation and other cardiac surgery procedures

In patients with severe coronary artery disease PCI was performed prior to CAS. In patients planned for coronary artery bypass grafting or valvular surgery CAS procedures were performed at least 30 days prior to the scheduled surgery.

Early and late follow-up, and definition of the complications

All cardiovascular, neurological and local complications occurring during the index hospitalisation and after discharge, up to 30 days following the procedure, were recorded (adverse events – AE). Major adverse cardiac and cerebrovascular events (MACCE) such as myocardial infarctions (MI), stroke and death were also evaluated in this time period. Transient cerebral ischaemia following the procedure was defined as occurrence of new or exacerbation of previously existing neurological symptoms with total recovery within 24 hours. In order to provide reliable assessment of neurological state patients were systematically followed by the neurologist, both in the peri-procedural period and during the late follow-up. All patients underwent clinical and ultrasound examination twice a year. Patients with suspected recurrence of carotid artery stenosis were referred for angiography and in those with severe restenosis repeat PTA with balloon or stent was performed. Incidence of MACCE during long-term follow-up was assessed.

Statistical analysis

Parametric variables were reported as means and standard deviations, non-parametric as absolute

numbers and percentages. Parametric variables were compared between groups using Student's t-test. Comparisons of the frequency of the non-parametric variables between subgroups were carried out using χ^2 and F-Cox tests. A survival curve was calculated based on Kaplan-Meier analysis. Using Statistica 6.0 PL software (Statsoft) univariate and multivariate discriminating analysis was carried out in order to identify predictors of increased periprocedural risk as well as cardiac and cerebrovascular events during late follow-up.

Results

In 223 patients, 256 PTA-CA procedures were performed on 268 cephalad arteries (carotid, vertebral, brachio-cephalic trunk). Of these, 252 (98.4%) procedures were successful. Distal cerebral protection using a vascular filter was instituted during 132 (51.5%) procedures. In 36 patients simultaneous coronary angioplasty was performed and in 46 – angioplasty of other arteries. The type and number of dilated arteries are summarised in Table III. Twelve (4.6%) MACCE in the early 30-day period were recorded and they included: stroke in 7 (2.7%) patients, MI in 3 (1.1%) patients and 2 (0.8%) deaths. The cause of the first death was haemorrhage to the cerebral ventricles, and of the second coronary in-stent thrombosis leading to cardiogenic shock in a patient not taking anti-platelet medications. Additionally, TIA was observed in 8 patients, pulmonary oedema in 3 patients, and central retinal artery embolism and contrast-induced nephropathy in single patients.

Table III. Arteries treated with percutaneous angioplasty

Number of all arteries	335
– cephalad	268
– coronary	44
– other	23
Internal carotid artery	242
Common carotid artery	7
External carotid artery	4
Vertebral artery	15
Subclavian artery/brachiocephalic artery	4+4
Renal artery	3
Iliac artery/femoral artery	10

The detailed data of all early events observed in both groups are presented in Table IV. The incidence of MACCE at 30 days was higher in the high-risk group, but the difference was not significant (6.07 vs. 1.33%; p=0.19). The risk of at least one AE was significantly higher in the high-risk group (p=0.03). In the group of procedures conducted without any distal protection, the incidence of strokes tended to be higher, although not significantly, than in the group using such protection (2.27 vs. 3.22% respectively; p=0.93). When comparing isolated procedures on cephalad arteries with combined procedures on cephalad and coronary arteries, no significant differences of rate of MACCE (3.6 vs. 5.5%; p=0.93) were seen. Distributions of risk factors for procedures with or without AE as well as with or without MACCE at 30 days are presented in Tables V and VI.

During the long-term follow-up (50.3±20.0 months) 16 (7.1%) deaths, 9 (3.5%) strokes and 6 (2.3%) cases of angiographically proven restenosis were recorded. Annual survival and annual survival free from MACCE by Kaplan-Meier's analysis were 94.9 and 89.0% respectively, with a trend towards a higher survival in the group of low-risk procedures (F-Cox=2.46; p=0.19 and F-Cox=2.17; p=0.09). The function of survival and survival free from MACCE in the studied subgroups is displayed in Figures 2-5. Distribution of risk factors in groups of patients with or without MACCE in long-term follow-up is presented in Table VII.

Table IV. Thirty-day incidence of complications in high-risk and low-risk groups of patients

Type of complication	High-risk group (n=181)	Low-risk group (n=75)	p
Death	2 (1.1%)	0	NS
Stroke	6 (3.3%)	1 (1.3%)	NS
Myocardial infarction	3 (1.7%)	0	NS
Transient ischaemic attacks	6 (3.3%)	2 (2.7%)	NS
Pulmonary oedema	3 (1.7%)	0	NS
Acute renal failure	1 (0.6%)	0	NS
Embolisation of central retinal artery	1 (0.6%)	0	NS
Hypotension requiring prolonged (>12 h) administration of catecholamines	4 (2.2%)	0	NS
MACCE	11 (6.1%)	1 (1.3%)	NS
At least one adverse event	26 (14.4%)	3 (4%)	0.03

Table V. Distribution of risk factors for procedures with or without AE at 30 days

Risk factor	Procedures without AE (n=227)	Procedures with AE (n=29)	p
Male gender [%]	64.5	77.3	0.33
Coronary artery disease [%]	93.6	95.4	0.91
Coronary artery disease requiring PCI/CABG [%]	35.0	40.0	0.75
Decreased left ventricular ejection fraction <40% [%]	28.6	36.4	0.60
Peripheral artery disease [%]	27.8	13.6	0.24
Hypertension [%]	68.4	77.3	0.53
Type 2 diabetes mellitus [%]	25.2	40.9	0.18
Hyperlipidaemia [%]	57.7	68.2	0.47
History of stroke/transient ischaemic attack [%]	37.2	45.4	0.59
Significant heart valve disease [%]	2.6	4.5	0.89
Bilateral stenosis of carotid artery [%]	20.9	27.3	0.67
Age [years]	65.0±8.5	67.4±8.2	0.20

Table VI. Distribution of risk factors for procedures with or without MACCE at 30 days (univariate analysis)

Risk factor	Procedures without MACCE (n=244)	Procedures with MACCE (n=12)	p
Male gender [%]	65.2	77.8	0.67
Coronary artery disease [%]	93.9	88.9	0.93
Coronary artery disease requiring PCI/CABG [%]	35.2	44.4	0.83
Decreased left ventricular ejection fraction <40% [%]	29.1	33.3	0.92
Peripheral artery disease [%]	27.1	11.1	0.49
Hypertension [%]	69.2	66.6	0.84
Type 2 diabetes mellitus [%]	26.7	22.2	0.93
Hyperlipidaemia [%]	58.3	66.6	0.88
History of stroke/transient ischaemic attack [%]	37.6	44.4	0.95
Significant heart valve disease [%]	2.4	11.1	0.60
Bilateral stenosis of carotid artery [%]	21.0	33.3	0.64
Age [years]	65.1±8.5	67.7±9.5	0.37

Table VII. Distribution of risk factors in groups of patients with or without MACCE in long-term follow-up (univariate analysis)

Risk factor	Procedures free from MACCE (n=222)	Procedures with MACCE (n=33)	p
Male gender [%]	64.0	78.8	0.14
Coronary artery disease [%]	93.7	97.0	0.73
Coronary artery disease requiring PCI/CABG [%]	34.2	45.4	0.29
Decreased left ventricular ejection fraction <40% [%]	27.9	39.4	0.25
Peripheral artery disease [%]	28.8	12.1	0.07
Hypertension [%]	68.9	72.7	0.81
Type 2 diabetes mellitus [%]	26.1	30.3	0.77
Hyperlipidaemia [%]	58.5	60.6	0.97
History of stroke/transient ischaemic attack [%]	37.4	42.4	0.72
Significant heart valve disease [%]	1.8	9.1	0.07
Bilateral stenosis of carotid artery [%]	21.2	24.2	0.86
Age [years]	64.8±8.4	68.1±8.7	0.04

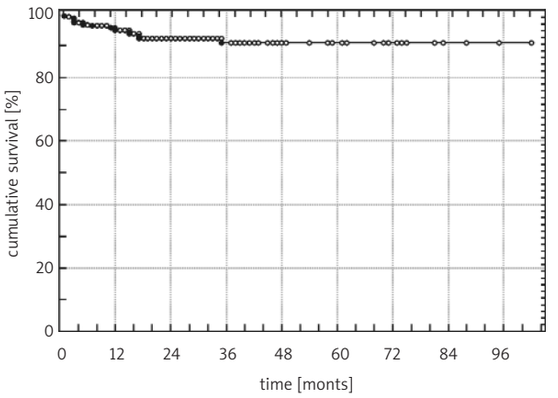

Figure 2. Long-term survival of the whole study population – Kaplan-Meier analysis

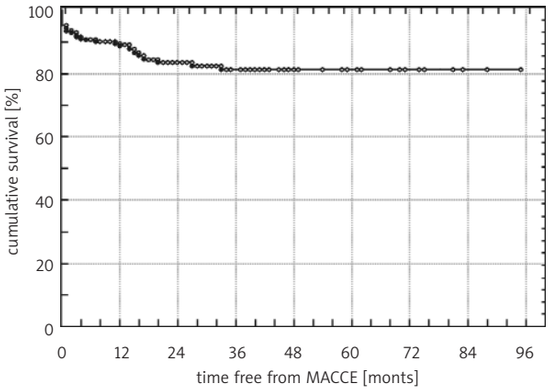

Figure 3. Long-term survival free from MACCE of the whole study population – Kaplan-Meier analysis

Table VIII. Association between analysed factors and the risk of severe cardio-cerebrovascular events at 30 days (multivariate analysis)

Variable	p
Type of protection	0.02
High-risk group	0.05
Diabetes mellitus	0.07
Male gender	0.11
Peripheral artery disease	0.11

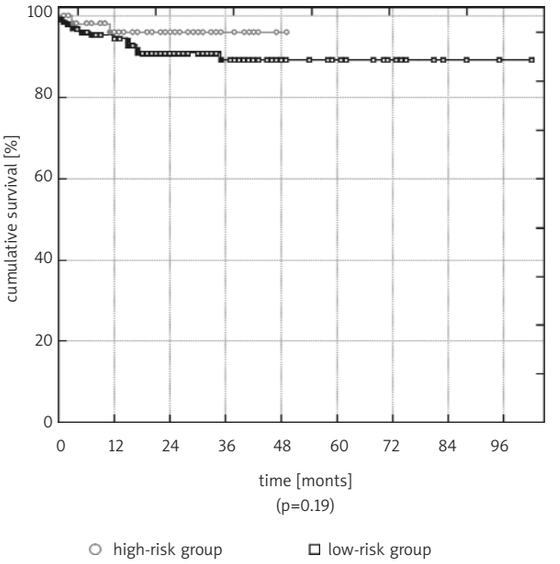

Figure 4. Long-term survival in high- and low-risk group – Kaplan-Meier analysis

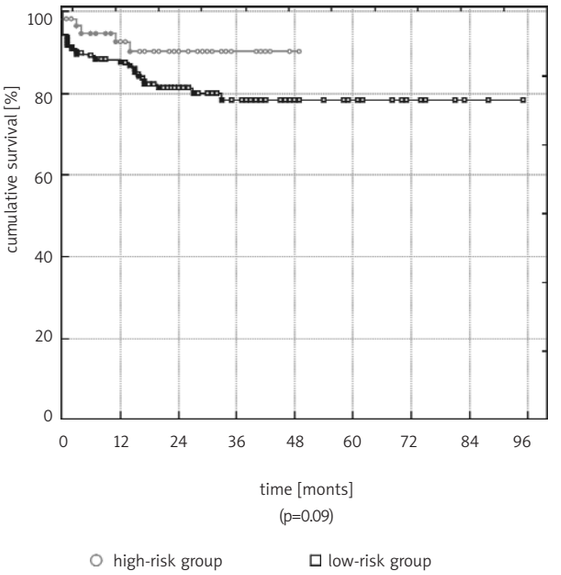

Figure 5. Long-term survival free from MACCE in high- and low-risk group – Kaplan-Meier analysis

The only factor which significantly affected the incidence of adverse events in the periprocedural period was the type of neuroprotection (Table VIII). Introduction of new protection devices (FilterWire, Accunet, Emboshield) resulted in a decreased rate of cerebrovascular events compared with the previously used filter (Angioguard). There were no significant differences regarding other analysed parameters.

Male gender and peripheral artery atherosclerosis were found to be predictors of more frequent cardiac and cerebrovascular events during long-term follow-up (Table IX).

Table IX. Association between analysed factors and the risk of severe cardio-cerebrovascular events in long-term follow-up (multivariate anaysis)

Variable	p
Male gender	0.002
Peripheral artery disease	0.02
Other angioplasty of the cephalic arteries procedures	0.12
Valvular disease	0.14
High-risk group	0.15
Decreased left ventricular ejection fraction	0.15
Hypertension	0.27

Discussion

This study reports early and late outcomes derived from a prospective registry of PTA-CA procedures conducted in patients with significant stenosis of carotid or vertebral arteries. It is so far the longest observation of such a large group of patients in Poland. Furthermore, the significant clinical value of this registry is related to the broad spectrum of patients selected for CAS procedure, the procedures being conducted by the same group of operators, extensive investigations and complex treatment of peripheral and coronary arteries atherosclerosis.

The main criterion for qualifying a patient for the procedure was the degree of cephalad artery stenosis. In accordance with the American Heart Association recommendations we agree that the degree of stenosis and not only the clinical symptoms should eventually determine the qualification of the patient for the procedure. This strategy is based on the results of a randomised ACAS study [4], which unequivocally demonstrated the advantages of surgical treatment of asymptomatic patients. Furthermore, our report as well as the SAPPHIRE trial [7] show that qualification of patients for surgical treatment is much broader in cases of CAS than in CEA due to the numerous contraindications to CEA (bilateral changes in the carotid arteries, stenosis in the proximal and distal part of the carotid artery, condition after radiotherapy or surgery in the cervical region prior to CEA, unstable angina). This situation is well described in the SAPPHIRE study, in which out of 723 patients with major occlusion of the carotid arteries, only 307 patients were randomised, and the remaining subjects were incorporated in the CAS record – 409 (56.6%), or CEA – 7 (1%). Therefore, from the initial group, 716 (99%) patients were selected for CAS, and only 314 (43.4%) for CEA.

Our observations are similar to the results of randomised studies which demonstrated the efficacy and safety of CAS procedures in patients from both the high-risk [7], as well as the low-risk group (CARESS study) [9].

The efficacy of the procedure in our report is high (98.4%) and does not differ from the results of the global registry (98.9%) and ALKK (98.1%) [10-12].

The low risk of restenosis after CAS procedures in our patients (2.3%) confirms a positive late effect of this type of treatment, which is in agreement with previous reports showing that the percentage of restenosis after CAS procedures is within 3-6%, whereas it is much higher (9-18%) after CEA.

Current recommendations of the American Heart Association concerning procedures on the carotid arteries describe the acceptable frequency of major cerebral events (stroke, death) occurrence at the level of 3% for asymptomatic patients and 6% for patients with symptomatic occlusion of the carotid artery. In our report the risk of MACCE occurrence in the early 30-day observation period was on average 4.6%, being in the high-risk group 6.0%, and in the low-risk group – 1.3%. The occurrence of MI, stroke or death in the 30-day observation period was 1.1, 2.7 and 0.8%, respectively. These results are comparable with those obtained for CAS procedures in the SAPPHIRE study (respectively 3.9, 3.1 and 0.6%) [7]. Also annual survival without MACCE according to Kaplan-Meier analysis was comparable with the results of the SAPPHIRE study (respectively 89.0% in our study and 87.8% in the quoted study). Coexisting diseases and factors such as advanced coronary artery disease, valvular disease, and neurological events in the past had a major influence on the survival of patients after the procedure and the occurrence of MACCE, which is well illustrated in the graphs comparing the survival of patients from high-risk and low-risk groups (Figures 4 and 5). Comparing the groups of patients in our report we have observed a trend towards a higher rate of MACCE at 30 days in the high-risk group. This difference was present throughout the whole follow-up period, but without a tendency to increase, which suggests that the efficacy of our strategy of comprehensive treatment in patients with generalised atherosclerosis is high.

Neuroprotection was used only during 51.5% of procedures because of the unavailability of the equipment until the year 2002. In our registry there were no significant differences in the incidence of ipsilateral stroke between the group of procedures conducted with or without neuroprotection. However, a big global registry of CAS demonstrated that distal protection systems decrease the risk of CNS embolisation with thrombotic material released from the atherosclerotic plaque in the artery being dilated, thus decreasing the risk of neurological complications and death (5.3 vs. 2.3%). This is why all CAS procedures are currently conducted using distal protection systems, as recommended by the guidelines. The fact that the type of protection device used had a significant impact on the

incidence of adverse events in the periprocedural period is quite an interesting observation. The introduction of new models of neuroprotection systems (FilterWire, Accunet, Emboshield) resulted in decreased incidence of adverse events as compared to the previously used filters (Angioguard).

The randomised SAPPHIRE study [7] demonstrated that CEA is associated with a higher number of peri- and postprocedural complications than CAS. Typical complications of endarterectomy include cardiac events, cranial nerve palsies in up to 27% of subjects, and scar formation, which can make repeat endarterectomy difficult. The low invasiveness of CAS procedures compared with the much more invasive CEA is of great importance. Patients usually choose the procedure which is less invasive, associated with a fast recovery, short hospitalisation and an opportunity to get back to everyday activities promptly. Cartoid stenting should constitute the method of choice for patients at a high surgical risk, especially as data available from CEA global registries demonstrate that coronary artery disease is a main source of severe complications in the peri- and postsurgical period in patients undergoing surgical vascular procedures, and also is the most frequent reason for disqualification from such procedures [13].

The contradictory results of the prematurely discontinued EVA-3S study, suggesting a higher rate of periprocedural complications after CAS than after CEA, are presumably related to the limited experience of operators conducting CAS procedures, low rate of enrolment as well as the absence of neuroprotection and double anti-platelet therapy in a significant proportion of patients randomised to CAS [14].

The analysis of patients in our registry revealed a high rate of coincidence of carotid and coronary artery disease (92.8%). The introduction of new diagnostic and therapeutic techniques enables comprehensive treatment of atherosclerosis and forces different specialists, namely cardiologists, neurologists and surgeons, to change the strategy of treatment of diffuse, multisystem atherosclerosis. Percutaneous implantation of stents into stenosed coronary as well as carotid and peripheral arteries may improve prognosis and decrease the risk of adverse cardiovascular events. Very often it is feasible to revascularise more arteries during one procedure or to plan the further stages of the therapy. Thus, in patients with high surgical risk, suffering from other, mainly cardiac comorbidities, the early and late results of CAS seem to be more beneficial than those of CEA. Furthermore, the indications for CAS are much broader, because a patient with stenosis of a cephalad artery is most often a patient with cardiac risk factors and should be treated accordingly [15]. Attention should be paid to the fact that hypertension and diabetes mellitus are frequent among all comorbidities and require optimal therapy to improve the patient's prognosis.

Doppler ultrasound is a non-invasive, precise method of carotid artery assessment, useful before and after the CAS procedure. It enables recognition of significant lesions in cephalad vessels deemed appropriate for percutaneous procedures and establishing a strategy of treatment. The role of Doppler ultrasound in patients after interventions on carotid arteries is indisputable. It allows early recognition of possible restenosis or stent malpositioning, making fast reintervention possible and preventing severe complications [16, 17].

Conclusions

Angioplasty of the cephalad arteries is a safe method of treatment associated with a low risk of restenosis. The low rate of early complications, particularly when the procedure is conducted using a distal protection device, as well as the limited number of severe cardiovascular events in the periprocedural period, make CAS an alternative method to CEA.

Performing the procedure in a selected group of high-risk patients, disqualified from surgical treatment, is associated with a higher risk of early complications. However, long-term results in this group of patients are comparable with the results achieved in a group of low-risk patients. This is probably due to proper treatment of atherosclerosis involving both coronary and peripheral arteries.

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Wczesne i odległe wyniki przezskórnej angioplastyki tętnic dogłowowych

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Streszczenie

Wstęp: Skuteczność chirurgicznej endarterektomii (ang. *carotid endarterectomy*, CEA) w zapobieganiu udarom u chorych z istotnymi zwężeniami w tętnicach szyjnych została potwierdzona badaniami klinicznymi z randomizacją. Stentowanie tętnic szyjnych (ang. *carotid stenting*, CAS) jest metodą coraz częściej stosowaną w praktyce klinicznej, a jej wczesne wyniki nie są gorsze od CEA. Ponadto techniki przezskórne (ang. *percutaneous transluminal angioplasty,* PTA) pozwalają na poszerzenie zwężeń innych tętnic dogłowowych (m.in. tętnic kręgowych).

Cel: Ocena wczesnych i odległych wyników angioplastyki tętnic dogłowowych (PTATG) w materiale własnym oraz analiza czynników wpływających na ryzyko wystąpienia incydentów sercowo-mózgowych w obserwacji wczesnej i odległej.

Metodyka: Prospektywnej analizie poddano 223 chorych [151 (67,7%) mężczyzn] w średnim wieku 65,3±38,6 roku, u których wykonano 256 zabiegów PTATG. Poszerzono 242 tętnice szyjne wewnętrzne, 7 tętnic szyjnych wspólnych oraz 15 kręgowych. U 34 chorych jednocześnie przeprowadzono angioplastykę wieńcową, a u 46 angioplastykę innych tętnic. Protekcję mózgową z użyciem filtru naczyniowego zastosowano w 51,5% procedur. Zabiegi podzielono na dwie grupy: większego (n=181) i mniejszego (n=75) ryzyka wystąpienia niepożądanych zdarzeń sercowo-naczyniowych, i przeprowadzono analizę wystąpienia ww. incydentów w obserwacji wczesnej i odległej.

Wyniki: Ciężkie powikłania sercowo-mózgowe (ang. *major adverse cardiac and cerebral events*, MACCE) w okresie okołozabiegowym (do 30 dni) wystąpiły w 12 (4,6%) przypadkach i obejmowały: udar mózgu – 7 (2,7%) chorych, zawał serca – 3 (1,1%) oraz zgon – 2 (0,8%). U 8 chorych obserwowano przemijające niedokrwienie mózgu, u 3 – obrzęk płuc, ponadto pojedyncze przypadki zatoru tętnicy środkowej siatkówki oraz nefropatii kontrastowej. Częstość występowania MACCE w obserwacji 30-dniowej była nieistotnie większa w grupie wysokiego ryzyka (6,07 *vs* 1,33%; NS), natomiast ryzyko wystąpienia jakiegokolwiek działania niepożądanego było istotnie większe w grupie wysokiego ryzyka (p=0,03). W grupie zabiegów bez protekcji częstość występowania udarów była nieistotnie większa niż w grupie z protekcją (odpowiednio 2,27 *vs* 3,22%; NS). Nie zaobserwowano istotnej różnicy w występowaniu MACCE pomiędzy zabiegami angioplastyki tylko tętnic dogłowowych a zabiegami jednoczesnej angioplastyki naczyń dogłowowych i wieńcowych (3,6 *vs* 5,5%; NS). W obserwacji odległej wynoszącej średnio 50,3±20,0 mies. obserwowano 16 (7,1%) zgonów, 9 (3,5%) udarów mózgu oraz 6 (2,3%) przypadków restenozy potwierdzonej angiograficznie. Roczne przeżycie oraz roczne przeżycie bez MACCE wg analizy Kaplana-Meiera wynosiło odpowiednio 94,9 i 89,0%, wykazując trend do lepszych wyników odległych w grupie niskiego ryzyka (F-Cox=2,46; p=0,19 oraz F-Cox=2,17; p=0,09).

Wnioski: Przezskórna wewnątrznaczyniowa angioplastyka tętnic dogłowowych jest skuteczną metodą leczenia zwężeń tych tętnic. Ryzyko wystąpienia groźnych incydentów sercowo-naczyniowych w okresie okołozabiegowym jest ograniczone, a wyniki odległe korzystne. Stentowanie tętnic szyjnych jest alternatywną metodą leczenia dla chirurgicznej endarterektomii.

Słowa kluczowe: przezskórna angioplastyka tętnic szyjnych, stentowanie tętnic szyjnych, angioplastyka tętnic dogłowowych

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