

Risk factors for carotid artery disease in patients scheduled for coronary artery bypass grafting

Anna Drohomirecka, Łukasz Koltowski, Paweł Kwinecki, Krzysztof Wronecki, Romuald Cichoń

MEDINET Heart Center, Wrocław, Poland

Abstract

Background: Carotid artery disease is thought to be a risk factor for neurological complications after cardiac surgery. Routine ultrasonographic screening is still not performed in every patient scheduled for coronary artery bypass grafting (CABG).

Aim: To assess factors which may facilitate the selection for elective carotid artery ultrasound examination in patients undergoing CABG.

Methods: 682 patients (mean age 63.2 ± 8.7 , range: 37–85 years) scheduled for CABG underwent preoperative duplex ultrasound examination of the carotid arteries. The following factors were collected and analysed: age, sex, LVEF, history of cerebrovascular accidents (stroke and/or TIA), myocardial infarction, and presence of hypertension, diabetes, unstable angina, chronic obstructive pulmonary disease, chronic kidney disease, left main stenosis $\geq 50\%$, lower-extremity peripheral arterial disease, and obesity (BMI $> 30 \text{ kg/m}^2$). Logistic regression analysis was used to determine the risk factors for carotid artery stenosis.

Results: Internal or common carotid artery stenosis $\geq 50\%$ was detected in 123 (18%) patients. Bilateral stenosis occurred in 35 (5.1%) patients, of whom 29 (4.5%) presented at least a monolateral vessel diameter reduction of $\geq 70\%$. History of cerebrovascular accidents, presence of lower-extremity peripheral arterial disease, and unstable angina were independent risk factors for at least monolateral vessel diameter reduction $\geq 50\%$. Although older age was also an independent predictor (Exp(B) = 1.035, $p < 0.05$), the ROC curve analysis did not reveal an age threshold above which the probability of detecting carotid disease increases significantly with satisfying sensitivity and specificity. The predictors of bilateral stenosis (at least one of them $\geq 70\%$) were a history of stroke, presence of left main disease, and lower-extremity peripheral arterial disease.

Conclusions: Carotid disease is common in patients scheduled for CABG. Preoperative carotid artery ultrasound examination should be performed, regardless of age, in all patients with more advanced symptomatic atherosclerosis, such as a history of cerebrovascular accidents, presence of lower-extremity peripheral arterial disease, left main disease, or unstable angina.

Key words: coronary artery surgery, carotid disease

Kardiol Pol 2010; 68, 7: 789–794

INTRODUCTION

Despite the development of anaesthetic and operative procedures, post-operative neurological deficits remain one of the most serious complications after coronary artery bypass grafting (CABG). Carotid artery stenosis (CAS) may potentially reduce blood flow to the brain during the operation and may be the source of emboli, which could result in stroke or tran-

sient ischaemic attack. Although CAS $> 50\%$ is an established risk factor for post-operative neurological complications [1], about half of patients who experience stroke do not suffer from significant carotid disease [2]. However, considering the fact that simultaneous carotid endarterectomy and CABG decrease the risk for post-operative stroke and stroke-related mortality [3], ultrasonographic screening for CAS seems a cli-

Address for correspondence:

lek. Anna Drohomirecka, MEDINET Heart Center, ul. Kamieńskiego 73A, 51–124 Wrocław, Poland, e-mail: adrohomirecka@tlen.pl

Received: 17.02.2010 Accepted: 21.04.2010

Table 1. Demographic and clinical characteristics of the studied population

	Total (n = 682)	Patients with carotid disease (n = 123)	Patients without carotid disease (n = 559)	P
Age	63.2 ± 8.7	65.6 ± 7.7	62.7 ± 8.8	0.0007
Women	140 (20.5%)	26 (21.1%)	114 (20.4%)	0.92
Prior CVA	70 (10.3%)	27 (22.0%)	43 (7.7%)	< 0.0000
Prior stroke	45 (6.6%)	18 (14.6%)	27 (4.8%)	0.0001
Prior TIA	31 (4.5%)	11 (8.9%)	20 (3.6%)	0.0098
LVEF [%]	54.4 ± 12.3	52.1 ± 12.9	54.8 ± 12.1	0.027
Prior MI	422 (61.9%)	81 (65.9%)	341 (61.0%)	0.32
Hypertension	507 (74.3%)	97 (78.9%)	410 (73.3%)	0.20
Diabetes mellitus	214 (31.4%)	44 (35.8%)	170 (30.4%)	0.25
Unstable angina	204 (29.9%)	47 (38.2%)	157 (28.1%)	0.0264
COPD	46 (6.7%)	10 (8.1%)	36 (6.4%)	0.50
Chronic kidney disease	37 (5.4%)	12 (9.8%)	25 (4.8%)	0.0193
Left main disease	158 (23.2%)	36 (29.3%)	122 (21.8%)	0.0765
Lower-extremity arterial disease	60 (8.8%)	19 (15.4%)	41 (7.3%)	0.0040
Obesity	210 (30.8%)	30 (24.4%)	180 (32.2%)	0.0894

CVA — cerebrovascular accidents; TIA — transient ischaemic attack; LVEF — left ventricular ejection fraction; MI — myocardial infarction; COPD — chronic obstructive pulmonary disease

nically reasonable procedure. In many cardiac centres, duplex ultrasonography is still not performed in every patient scheduled for CABG. Consequently, the aim of this study was to determine risk factors which may facilitate the selection for elective neck artery ultrasound examination in patients undergoing CABG.

METHODS

Study population

We reviewed all 892 records of patients admitted to our hospital and scheduled for isolated CABG. Records without a result of preoperative duplex ultrasound were excluded from analysis. Finally, the examined group consisted of 682 patients. Patients with a history of previous carotid endarterectomy or carotid stenting were excluded from the study. The patients' characteristics are shown in Table 1.

Preoperative carotid artery evaluation

A vessel lumen diameter reduction of the internal or common carotid artery of ≥ 50%, measured according to the protocol used by the European Carotid Surgery Trial Collaborative Group [4] and which resulted in haemodynamic changes in blood flow, was considered significant CAS.

Risk factors and definitions

The following factors were collected and analysed: age, sex, left ventricular ejection fraction (LVEF), history of ce-

rebrovascular accidents (stroke and/or transient ischaemic attack — TIA), myocardial infarction (MI), presence of hypertension, diabetes, unstable angina, chronic kidney disease (CKD), lower-extremity peripheral arterial disease, chronic obstructive pulmonary disease (COPD), left main stenosis ≥ 50%, and obesity. Hypertension was considered when the patient took medication for hypertension or if systolic blood pressure was ≥ 140 mm Hg and/or diastolic blood pressure was ≥ 90 mm Hg in more than two repeated measurements performed by a physician before hospital admission. Diabetes was defined as glucose intolerance treated by diet or requiring hypoglycaemic medications (oral medication or insulin) before admission to hospital. Unstable angina was diagnosed in patients with new-onset angina (the first two months of angina, CCS [Canadian Cardiovascular Society] class III or IV), angina at rest of up to one week's duration, or angina increasing in severity to moderate or severe pain (increase of at least one CCS class to III or IV). Chronic kidney disease was defined as either kidney failure or glomerular filtration rate less than 60 mL/min per 1.73 m² for three or more months. Lower-extremity peripheral arterial disease included claudication, amputation, prior lower-extremity bypass, or absence of tibial posterior pulse. Chronic obstructive pulmonary disease was defined as chronic bronchitis and/or emphysema. Obesity was detected when the body mass index was > 30 kg/m².

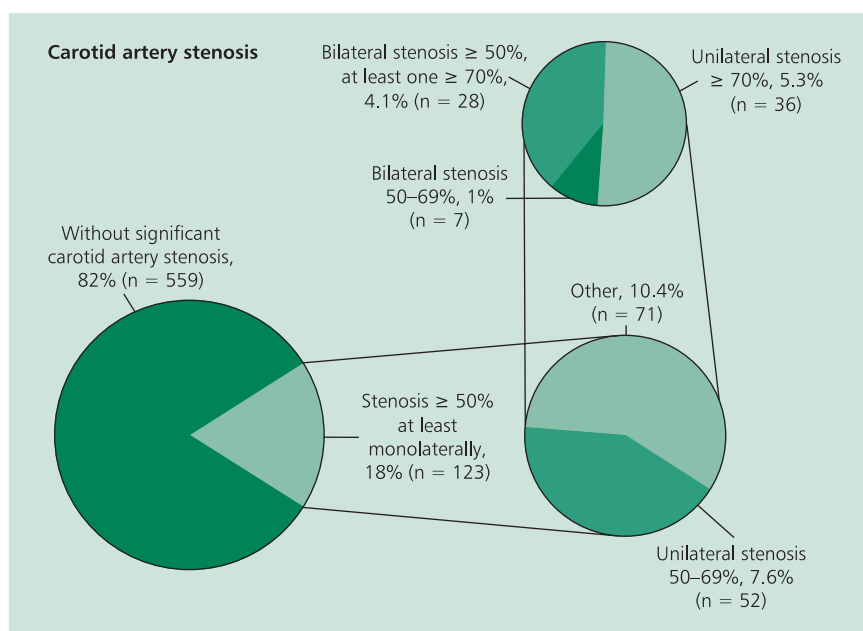


Figure 1. The distribution of carotid disease

Statistical analysis

Statistical analysis was performed using SPSS 14 for Windows. The χ^2 test was used to compare categorical variables. Continuous variables were compared using Student's *t* test. Logistic multiple regression analysis was used to determine the risk factors for the incidence of carotid disease. The optimum cut-off points were searched with the use of receiver operator characteristics (ROC) curve analysis. A *p* value < 0.05 was regarded as significant.

RESULTS

Internal or common CAS $\geq 50\%$ was detected in 123 (18%) patients. The distribution of CAS is shown in Figure 1. In the remaining 559 patients, there were no ultrasonographic signs of significant CAS. The clinical and demographic characteristics of both groups are compared in Table 1. Patients with CAS were significantly older than those without CAS, had sustained prior cerebrovascular accidents more frequently, and suffered more often from unstable angina, CKD, and lower-extremity peripheral arterial disease. The mean LVEF was lower in patients with CAS.

Logistic multiple regression analysis revealed the following independent risk factors for at least a unilateral vessel diameter reduction of $\geq 50\%$: a history of cerebrovascular accidents (odds ratio [OR]: 3.271, *p* < 0.001), presence of lower-extremity peripheral arterial disease (OR: 2.323, *p* < 0.001), unstable angina (OR: 1.588, *p* = 0.032), and advanced age (OR: 1.035 per year, *p* = 0.005). Although, older age was an independent predictor, ROC curve analysis did not reveal an age threshold above which the probability of CAS detection increases significantly with satisfying sen-

sitivity and specificity. Regardless of patient age, the presence of at least one of the above factors made it possible to detect CAS of $\geq 50\%$ with a sensitivity of 59.3% and specificity of 61%. The positive predictive value (PPV) and negative predictive value (NPV) were 25.1% and 87.2%, respectively. When at least two factors were required, the sensitivity for detecting CAS was 15.4%, specificity 95.9%, PPV 45.2%, and NPV 83.75%. All three risk factors were present in only one patient in the group with CAS, and in none in the group with normal carotid blood flow. That is why we did not continue the analysis. It is worth stressing that 50 (41%) of the 123 individuals with CAS did not present any of the above risk factors.

The predictors of bilateral stenosis (at least one of them $\geq 70\%$) were: a history of stroke (OR: 9.499, *p* < 0.001), presence of left main disease (OR: 2.376, *p* = 0.039), and lower-extremity peripheral arterial disease (OR: 4.997, *p* = 0.001). As before, we determined the predictive values of the separate risk factors. When at least one risk factor was present, the sensitivity was 75% and specificity was 67.4%. The NPV was 98.4%, but the PPV was only 8.97%. In the presence of two or three (in one patient) risk factors, the sensitivity was 21.4% and specificity was 96.6%. The PPV and NPV were 21.4% and 96.6%, respectively.

DISCUSSION

The main purpose of ultrasound screening is the selection of patients with high-grade CAS who could benefit from carotid endarterectomy performed as a staged or synchronous procedure with CABG. Admittedly, there is a lack of randomised studies which definitively prove the advantage of carotid en-

arterectomy over conservative treatment in preventing post-operative neurological complications. However, according to the observation from retrospective analysis performed by De Feo et al. [3], routine screening for significant CAS followed by carotid endarterectomy decreased the risk of post-operative stroke and stroke-related mortality. Moreover, in the era of minimally invasive procedures, carotid artery stenting has become an attractive alternative to carotid surgery. The first studies showed that carotid artery stenting could be safely performed before CABG (even in high-risk patients) and compared with synchronous carotid endarterectomy and CABG, it tended to result in a lower rate of adverse events (MI, stroke, and death) [5]. In view of the fact that CAS is a risk factor for stroke occurring in both the early [6] and late post-operative periods [7], all strategies which may reduce this risk should be promoted.

To the best of our knowledge, this is the first Polish study evaluating the prevalence of CAS in patients referred for CABG and risk factors which could facilitate the decision about a preoperative ultrasound examination of carotid arteries. There are some data documenting coexistence of coronary artery disease and peripheral vascular disease [8, 9] however, in patients undergoing coronary angiography, and coronary artery disease was defined as at least one coronary stenosis > 50%. Thus, the results could not be directly compared with those of our study.

It has been shown that significant CAS is common in patients undergoing CABG. In studies which examined all patients scheduled for CABG, CAS \geq 50% was detected in almost one in seven patients. Aboyans et al. [10] reported a 13.1% prevalence of CAS. Fukuda et al. [11] detected significant CAS in 14.3% of CABG patients. In the population included in our study, the prevalence of CAS was even higher (18%). This value is comparable with that reported by Fukuda et al. ($p = 0.14$), but significantly greater than that reported by Aboyans et al. ($p = 0.008$). The difference is more interesting when one considers that the individuals examined by Aboyans et al. [10] were older than our study group [mean age (SD): 66.9 ± 9.1 vs 63.8 ± 8.7 years]. This may suggest that CAS has become an increasing clinical problem in younger patients. Another possible explanation is that the observed relationship is a local phenomenon. In our study, there were 252 patients younger than 60. Of them, 32 (12.7%) had at least unilateral CAS \geq 50%, which constituted 26% of all patients with CAS. Furthermore, based on results of logistic multiple regression analysis which revealed advanced age as an independent risk factor for CAS, we tried to determine the optimal cut-off point over which the probability of disease detection increased significantly. Unfortunately, the ROC curve analysis did not reveal an age threshold over which CAS occurred definitely more frequently. Moreover, age was not an independent predictor for bilateral stenoses with one of them \geq 70%. Eight of the 28 (28.6%) patients with this type of stenosis

were younger than 60. In conclusion, we would recommend that the decision about preoperative carotid artery ultrasound screening should not be limited to older patients.

We attempted to identify predictive factors which could facilitate the selection for preoperative ultrasound carotid examination. We chose 13 clinical parameters which are, except for COPD, related to the genesis or symptoms of atherosclerosis. We did not collect data on carotid bruit. The poor predictive value of carotid bruit has been described previously [4]. Aboyans et al. [10] reported that 78% of cases with stenosis were 'silent' and, conversely, 70% of neck bruits were not related to carotid lesions. The number of years of smoking cigarettes, and the number of cigarettes smoked, were not available for all patients and were not analysed, which is a potential weakness of the study.

The independent risk factors were defined with the use of multiple regression logistic analysis for two types of CAS, the first being the smallest degree of lesion which could be considered as significant (at least unilateral internal or common CAS \geq 50%) and the second the stenosis type at greatest risk for neurological complications (bilateral vessel diameter reduction \geq 50%, at least one of them \geq 70%). Except for age, the predictors of both CAS types were similar. Indeed, left main disease and unstable angina are not synonymous, but the association between them is well known and clinically explicable [12]. Consequently, we also observed that the two factors were related: left main disease was confirmed more frequently in patients with unstable angina (36.8% vs 17.4%, $p < 0.0001$). Although we have not found any study in the literature which evaluated and confirmed unstable angina as a predictor of CAS, we believe that individuals with more symptomatic ischaemic heart disease may be at higher risk for atherosclerotic lesion in carotid arteries.

Prior cerebrovascular accidents (defined as stroke or transient ischaemic attack) and lower-extremity peripheral arterial disease have already been reported by other investigators as co-morbidities associated with CAS [5, 13–16]. Our study similarly showed that they are the strongest predictors of CAS. However, we found that subjects with CAS suffered more than twice as frequently from CKD. Multivariable analysis, however, did not support the hypothesis that renal dysfunction could be an independent predictor of CAS. Nevertheless, considering that CKD increases the risk of death and cardiovascular events [17] and may adversely influence the outcome of carotid artery stenting [18], we believe that it is a co-morbidity which may indicate a more advanced atherosclerotic process manifested in different vascular pools, for example by the coexistence of coronary artery disease and CAS. Indeed, there are still many uncertainties as to the relationship between atherosclerosis and CKD because it is difficult to determine whether renal impairment accelerates the atherosclerotic lesions per se, or whether the proatherosclerotic effect is related to numerous coexisting risk factors.

In our study group, the presence of another medical burden, such as diabetes mellitus and hypertension, which have been determined by some authors as risk factors for carotid disease [7, 10, 19, 20], was comparable in patients with significant carotid disease and in those with normal carotid blood flow.

The above-mentioned clinical parameters may indicate a need for preoperative carotid ultrasound examination. However, we did not succeed in providing a combination of factors which could predict the presence of CAS with satisfactory specificity and sensitivity. Neither single nor combined variables achieved PPV > 45%, whereas NPV was always > 80%, reaching even 98%. This means that in the absence of the above-mentioned risk factors, CAS could be excluded with high probability, but the presence of one or several risk factors does not significantly increase the disease detection rate.

Limitations of the study

The study was a retrospective review of medical records and did not cover all patients referred to isolated CABG in our centre. Some patients undergoing urgent surgery, and some younger patients, were not included in the study due to lack of ultrasonographic examination.

CONCLUSIONS

Carotid disease is common among patients scheduled for CABG. Optimally, preoperative ultrasound screening should be performed in all patients referred for CABG. If this is not possible, carotid artery ultrasound examination should be carried out at least in patients with more advanced symptomatic atherosclerosis (history of cerebrovascular accidents, presence of lower-extremity peripheral arterial disease, left main disease, or unstable angina), regardless of age.

References

- D'Agostino RS, Svensson LG, Neumann DJ et al. Screening carotid ultrasonography and risk factors for stroke in coronary artery surgery patients. *Ann Thorac Surg*, 1996; 62: 1714–1723.
- Naylor AR, Mehta Z, Rothwell PM et al. Carotid artery disease and stroke during coronary artery bypass: a critical review of the literature. *Eur J Vasc Endovasc Surg*, 2002; 23: 283–294.
- De Feo M, Renzulli A, Onorati F et al. The risk of stroke following CABG: one possible strategy to reduce it? *Int J Cardiol*, 2005; 98: 261–266.
- Elwertowski M., Małek G. Ultrasonografia tętnic szyjnych. In: Małek G et al. eds. *Ultrasonografia kliniczna. Zastosowania kliniczne*. Vol. 1. Medipage, Warszawa 2003: 82.
- Ziada KM, Yadav JS, Mukherjee D et al. Comparison of results of carotid stenting followed by open heart surgery versus combined carotid endarterectomy and open heart surgery (coronary bypass with or without another procedure). *Am J Cardiol*, 2005; 96: 519–523.
- Stamou SC, Hill PC, Dangas G et al. Stroke after coronary artery bypass: incidence, predictors, and clinical outcome. *Stroke*, 2001; 32: 1508–1513.
- Schachner T, Zimmer A, Nagele G et al. Risk factors for late stroke after coronary artery bypass grafting. *J Thorac Cardiovasc Surg*, 2005; 130: 485–490.
- Kablak-Ziembicka A, Tracz W, Przewlocki T et al. Association of increased carotid intima-media thickness with the extent of coronary artery disease. *Heart*, 2004; 90: 1286–1290.
- Przewlocki T, Kablak-Ziembicka A, Kozanecki A et al. Polyvascular extracoronary atherosclerotic disease in patients with coronary artery disease. *Kardiologia Pol*, 2009; 67: 978–984.
- Aboyans V, Lacroix P, Guilloux J et al. A predictive model for screening cerebrovascular disease in patient undergoing coronary artery bypass grafting. *Interactive CardioVascular Thor Surg*, 2005; 4: 90–95.
- Fukuda I, Gomi S, Watanabe K et al. Carotid and aortic screening for coronary artery bypass grafting. *Ann Thorac Surg*, 2000; 70: 2034–2039.
- Maziak DE, Rao V, Christakis GT et al. Can patients with left main stenosis wait for coronary artery bypass grafting? *Ann Thorac Surg*, 1996; 61: 552–527.
- Sheiman RG, d'Othée BJ. Screening carotid sonography before elective coronary artery bypass graft surgery: who needs it. *AJR*, 2007; 188: W475–W479.
- Fukuda I, Ohuchi H, Sato M et al. Carotid screening with duplex scanning before coronary artery bypass. *Nippon Kyobu Geka Gakkai Zasshi*, 1996; 44: 478–483.
- Hill AB, Obrand D, Steinmetz OK. The utility of selective screening for carotid stenosis in cardiac surgery patients. *J Cardiovasc Surg (Torino)*, 1999; 40: 829–836.
- Salasidis GC, Latter DA, Steinmetz OK et al. Carotid artery duplex scanning in preoperative assessment for coronary artery revascularization: the association between peripheral vascular disease, carotid artery stenosis, and stroke. *J Vasc Surg*, 1995; 21: 154–160.
- Go AS, Chertow GM, Fan D et al. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. *Engl J Med*, 2004; 351: 1296–1305.
- Saw J, Gurm HS, Fathi RB et al. Effect of chronic kidney disease on outcomes after carotid artery stenting. *Am J Cardiol*, 2004; 94: 1093–1096.
- Rath PC, Agarwala MK, Dhar PK et al. Carotid artery involvement in patients of atherosclerotic coronary artery disease undergoing coronary artery bypass grafting. *Indian Heart J*, 2001; 53: 761–765.
- Shirani S, Boroumand MA, Abbasi SH et al. Preoperative carotid artery screening in patients undergoing coronary artery bypass graft surgery. *Arch Med Res*, 2006; 37: 987–990.

Czynniki ryzyka występowania zmian miażdżycowych w tętnicach szyjnych u chorych zakwalifikowanych do pomostowania naczyń wieńcowych

Anna Drohomirecka, Łukasz Kołtowski, Paweł Kwinecki, Krzysztof Wronecki, Romuald Cichoń

Dolnośląskie Centrum Chorób Serca MEDINET, Wrocław

Streszczenie

Wstęp: Istotne hemodynamicznie miażdżycowe zwężenia w tętnicach szyjnych są uznanym czynnikiem ryzyka powikłań neurologicznych po zabiegach kardiologicznych. Badanie ultrasonograficzne tętnic dogłównych nie zawsze jest rutynowo przeprowadzane u wszystkich chorych zakwalifikowanych do pomostowania naczyń wieńcowych. W szczególności dyskusyjne jest wykonywanie badania u chorych młodszych.

Cel: Celem niniejszej pracy było określenie czynników ryzyka występowania zwężeń w tętnicach szyjnych mogących ułatwiać dobór chorych do badań ultrasonograficznych.

Metody: Ultrasonograficznemu badaniu z opcją dopplerowską tętnic szyjnych poddano 682 chorych (wiek: $63,2 \pm 8,7$, 37–85 lat) zakwalifikowanych do pomostowania naczyń wieńcowych. Stworzono bazę danych uwzględniającą następujące czynniki demograficzne i kliniczne: wiek, płeć, frakcję wyrzutową lewej komory, wywiad w kierunku przebytych incydentów naczyniowo-mózgowych (udar lub TIA), zawału serca, występowanie nadciśnienia tętniczego, cukrzycy, dławicy niestabilnej, przewlekłej obturacyjnej choroby płuc, przewlekłej choroby nerek, zwężenia pnia lewej tętnicy wieńcowej $\geq 50\%$, miażdżycy zarostowej kończyn dolnych i otyłości. Wykorzystano analizę regresji logistycznej w celu określenia czynników ryzyka występowania zwężeń w tętnicach szyjnych.

Wyniki: Zwężenie w tętnicy szyjnej wspólnej lub wewnętrznej $\geq 50\%$ stwierdzono u 128 (18%) chorych. Obustronną stenozę tętnic szyjnych wykryto u 35 (5,1%) pacjentów, przy czym u 29 (4,5%) z nich przynajmniej po jednej stronie redukcja światła naczynia była większa niż 70%. Przebyte incydenty naczyniowo-mózgowe, obecność miażdżycy zarostowej kończyn dolnych i dławicy niestabilnej stanowiły niezależne czynniki ryzyka wystąpienia istotnych zwężeń w tętnicach szyjnych w badanej populacji chorych. Mimo że podeszły wiek był również czynnikiem ryzyka ($\text{Exp}(B) = 1,035$; $p < 0,05$), to w analizie krzywej ROC nie udało się wyznaczyć wartości progowej, powyżej której to ryzyko znacząco by wzrastało. Predyktorami występowania obustronnych zwężeń w tętnicach szyjnych (w tym co najmniej jedno $\geq 70\%$) były: przebyty udar, istotne zwężenia pnia lewej tętnicy wieńcowej i miażdżycy kończyn dolnych.

Wnioski: Istotne hemodynamicznie zmiany miażdżycowe w tętnicach szyjnych występują u znacznego odsetka chorych kierowanych na zabieg pomostowania naczyń wieńcowych, dlatego też uzasadnione jest wykonywanie oceny ultrasonograficznej tętnic szyjnych u wszystkich chorych kwalifikowanych do chirurgicznej rewaskularyzacji wieńcowej, jeśli tylko istnieją takie możliwości. Natomiast badanie to powinno być przeprowadzone obligatoryjnie, niezależnie od wieku pacjenta, w grupie obciążonej czynnikami ryzyka, takimi jak: wywiad w kierunku incydentów naczyniowo-mózgowych, niestabilnej dławicy piersiowej, miażdżycy zarostowej tętnic kończyn dolnych lub istotnego zwężenia pnia lewej tętnicy wieńcowej.

Słowa kluczowe: pomostowanie naczyń wieńcowych, miażdżycy tętnic szyjnych

Kardiologia 2010; 68, 7: 789–794

Adres do korespondencji:

lek. Anna Drohomirecka, Dolnośląskie Centrum Chorób Serca MEDINET, ul. Kamińskiego 73A, 51-124 Wrocław, e-mail: adrohomirecka@tlen.pl

Praca wpłynęła: 17.02.2010 r. Zaakceptowana do druku: 21.04.2010 r.