PROGNOSTIC CRITERIA AND TREATMENT FOR PATIENTS CANDIDATES FOR SURGERY OR PERCUTANEOUS CAROTID REPERFUSION

Marius Militaru[1,2], Anda Militaru[2,3], Daniel Lighezan[1,2], Lucian Petrescu[2,3], Mihaela Simu[2,4]

[1]Municipal Emergency Hospital, Timisoara
[2] „Victor Babes“ University of Medicine and Pharmacy, Timisoara
[3]Institute of Cardiovascular Diseases, Timisoara
[4]Emergency County Hospital, Timisoara

ABSTRACT

Background. Atherosclerosis is a systemic disease involved in cerebrovascular disease (CVD), coronary arterial disease (CAD), and peripheral arterial disease (PAD). Atherosclerotic carotid artery stenosis is an important cause of ischemic stroke, accounting for approximately 20-30% of all ischemic strokes. Carotid endarterectomy (CEA) and Carotid angioplasty stent (CAS) are interventional treatment for symptomatic and asymptomatic patients with severe carotid artery stenosis.

Purpose. The purpose of this study was to evaluate the prognostic and treatment criteria in patients with severe carotid uni/bi-lateral stenosis in different circumstances: symptomatic/asymptomatic, with recent or old ischemic stroke, candidates for (CEA) or stent (CAS), with/without involvement of coronary arteries and peripheral endothelial function.

Material and methods. The study included 85 patients with severe carotid stenosis (over 70%) that have been evaluated for CEA or CAS. Patients were evaluated with Carotid Doppler and/or Angio CT of the cervical region, cardiac ultrasound and cerebral/coronary/peripheral angiography, thus assessing the degree of coronary and peripheral involvement. The following have been calculated: ejection fraction (EF) (%), telediastolic volume (TDV) (ml), overall cardiovascular risk - blood pressure score (Score BP), (ranging 1-4 according to severity) and 2 composite scores: global cardiovascular and hemodynamic risk score (GCVHRS), (ranging 1-10 according to risk factors summation) and organic vascular risk score (OVRS), (ranging 1-10 according to the number and topographic status of stenosis). Patients were divided into four groups: a) with carotid stenosis only (CaAS), b) with CaAS damage and coronary stenosis (CoAS), c) with CaAS damage and peripheral stenosis (PAS) and d) global vascular involvement (CaAS,CoAS,PAS). All study patients were compared with 85 matched patients with cardiovascular risk factors without signs of clinical organ damage.

Results. Among the 85 patients with severe carotid stenosis, 52 (61.2%) patients had ICA stenosis between 90%-99%, 37 (43.5%) patients had CaAS involvement and 14 (16.5%) patients had multiple organ vascular damage. GCVHRS was significantly higher in the patient group with both CaAS and CoAS (scoring 5.80+/-2.33*) and also OVRS in patients with severe multiple organ vascular involvement (scoring of 6.78+/-1.42*), compared to the other groups of patients ($p < 0.05$). The hemodynamic risk evaluation in CaAS had a EF mean of 52.27+/-7.56 (%) and a TDV mean of 92.13+/-30.27* (ml) while in the global vascular involvement group EF dropped to a mean of 45.71+/-13.56 (%) and TDV increased to a mean of 124.28+/-51.38 (ml).

Conclusions. Higher composite scores (GCVHRS and OVRS) and decrease of EF best correlated with: the degree of carotid stenosis, with the presence of left internal carotid involvement, with the presence of a contralateral involvement (stenosis/occlusion). Secondary vascular disease prevention is mandatory in patients with carotid, coronary and peripheral arterial disease. A composite vascular risk evaluation is useful for individually tailoring our interventional treatment strategy thus improving the global functional outcome of any given patient.

*P < 0.05

Keywords: carotid artery stenosis > 70%; endarterectomy/stent, ejection fraction, global cardiovascular and hemodynamic risk score, vascular organic risk score

Author for correspondence:
Daniel Lighezan, MD, PhD, Municipal Emergency Hospital, 5 Gh. Dima St., Timisoara, Romania
e-mail: dlighezan@gmail.com

Notes:
CEA – endarterectomy; CAS – carotid angioplasty stent, EF – Ejection fraction, BP – Blood preasure, GCVHRS – Global cardiovascular and hemodynamic risk score, OVRS – organic vascular risk score; ICA – Internal Carotid Artery; TDV – Telediastolic Volume; CaAS – Carotid artery stenosis, CoAS – Coronary artery stenosis, PAS – peripheral artery stenosis, Angio CT – computed tomography angiography.

INTRODUCTION

Atherosclerosis is a systemic disease involved in cerebrovascular disease (CVD), coronary arterial disease (CAD) and peripheral arterial disease (PAD), and clinical manifestation in one territory is predictive of clinical events in other territories. (1,2) Atherosclerotic carotid artery stenosis is an important cause of ischemic stroke, accounting for approximately 20-30% of all ischemic strokes. Carotid stenosis may manifest from asymptomatic carotid disease to a TIA or to an ischemic stroke in the cerebral territory supplied by the vessel. (3)

Patients with carotid and coronary arterial disease represent a particularly high risk group and is very important for clinicians to use the best treatment for this patients. (4).

Carotid Endarterectomy Trial Group established that CEA is the treatment for symptomatic/asymptomatic patients with high grade carotid stenosis (5-7). The results of the CREST study showed that outcomes with CAS in both the short and long term are similar to those with CEA and CAS is an alternative for treating carotid stenosis in high surgical risk patients, particularly those with co-morbidities and symptomatic high-grade stenosis. (8). Multiple trials comparing the two intervention CAS or CEA were often with conflicting results. The optimal management of symptomatic and asymptomatic carotid disease remains controversial, despite numerous clinical research. (9)

One study shows that in all patients with CAD, the screening for carotid atherosclerosis should be considered as detection of carotid disease may modify treatment strategy of these patients, with more aggressive medical therapy or interventional treatment CAS/CEA or, for patients with critical stenosis in both territories, combined coronary and carotid surgery in one or more steps. (10)

METHODS

Patients and technique

The study included 85 patients with severe carotid stenosis (over 70%) that have been evaluated for CEA or CAS. Patients were evaluated with Carotid Doppler Ultrasound according to the criteria NASCET (North American Symptomatic Carotid Endarterectomy Trial) and/or Angio CT of the cervical region, cardiac ultrasound and cerebral/coronary/peripheral angiography, thus assessing the degree of coronary and peripheral involvement. The patients with severe carotid uni/bilateral stenosis with cardiovascular risk factors were in different circumstances: symptomatic/asymptomatic, with recent/old ischemic stroke or TIA, candidates for endarterectomy (CEA) or stent (CAS), with/without involvement of coronary arteries and peripheral endothelial function.

Patients evaluated in the period 2011-2013 were divided into four groups:

a) with carotid stenosis only (CaAS);

b) with CaAS damage and coronary stenosis (CoAS);

c) with CaAS damage and peripheral stenosis (PAS);

d) global vascular involvement (CaAS, CoAS, PAS), compared with 85 matched patients with cardiovascular risk factors without signs of clinical organ damage.

The following risk scores were assessed: overall cardiovascular risk – blood pressure score (Score BP) and 2 composite scores: organic vascular risk score (OVRS) and global cardiovascular and hemodynamic risk score (GCVHRS).

Global cardiovascular risk scores were created by using standardization of hypertension according to low, moderate, high or very high cardiovascular risk and hemodynamic and global cardiovascular risk (GCVHRS) based on endothelial risk factors - metabolic, introducing in the score hypertension, diabetes, smoking, dyslipidemia, chronic kidney disease and values EF and TDV. Organic vascular risk score (OVRS) was created by using the degree of carotid symptomatic/asymptomatic arterial damage ipsi/contralateral, coronary symptomatic, peripheral and vertebral arterial damage.

Cardiovascular risk stratification in these categories: low, moderate, high and very high according to SBP, DBP and the prevalence of risk factors, organ damage, asymptomatic, diabetes, stages of symptomatic CKD and CVD.

***TABLE 1**. Risk score: score for global cardiovascular risk (blood pressure – mmHg) (Score BP)*

Score BP:

RISK BP	No
No	0
Low	1
Moderate	2
High	3
Very high	4

Other risk factor, asymptomatic organ damage or disease	**High normal SBP 130-139 or DBP 85-99**	**Grade I HT SBP 140-159 or DBP 90-99**	**Grade II HT SBP 160-179 or DBP 100-109**	**Grade III HT SBP > 180 or DBP > 110**
No other RF		Low risk	Moderate risk	High risk
1-2 RF	Low risk	Moderate risk	Moderate to high risk	High risk
> 3 RF	Low to moderate risk	Moderate to high risk	High risk	High risk
OD, CKD stage 3 or diabetes	Moderate to high risk	High risk	High risk	High to very high risk
Symptomatic CVD, CKD stage ≥ 4 or diabetes with OD/RFs	Very high risk	Very high risk	Very high risk	Very high risk

Note: BP = blood pressure; CKD = chronic kidney disease; CVD = cardiovascular disease; DBP = diastolic blood pressure; HT = hypertension; OD = organ damage; RF = risk factor; SBP = systolic blood pressure.

***TABLE 2.** Score for global cardiovascular risk*

GCVHRS

Global cardiovascular risk	No
Hypertension	1
Diabetes mellitus	2
Hyperlipemia	1
Smoke	2
EF < 50%; TDV > 100 ml **EF > 50%; TDV < 100 ml**	2 0
CKD	2
Total	10

***TABLE 3.** Score for organic vascular risk (OVRS): and hemodynamic H (EF, TDV):*

Vascular organic risk	No.
Peripheral arterial stenosis (lower extremity, renal, subclavian)	1
Symptomatic coronarian disease (Myocardial infarction, angina pectoris)	2
Asymptomatic carotid Stenosis	1
Symptomatic carotid Stenosis	2
Contralateral ICA stenosis/occlusion	2
Vertebral artery stenosis	2
Total	**10**

Note: EF – ejection fraction; TDV – telediastolic volume, CKD – chronic kidney disease

The following parameters have been calculated: EF (%), TDV (ml), Score BP (ranging 0-4 according to severity) , and 2 composite scores: GCVHRS (ranging 1-10 according to risk factors summation) and OVRS (ranging 1-10 according to the number and topographic status of stenosis).

Statistic analysis

Statistical analysis was performed using SPSS version 20.0 for Windows. Results were expressed in percentages for categorical variables, respectively in mean +/-standard deviation for continuous variables. Independent samples t-tests and chi-squared tests were used. Moreover, binary logistic regression with forward Wald stepwise method was performed to evaluate the risk factors. A value of $p < 0.05$ was considered statistically significant.

RESULTS

The study included 85 patients with a mean age of 64.02 +/-8.68, 25 (29.4%) women and 60 (70,6%) men, compared with 85 matched patients with a mean aged of 66.71 +/- 8.64, 38 (44.7%) men and 47 (55.3%) women, with cardiovascular risk factors without signs of clinical organ damage.

Out of all patients, 49 (57.6%) patients were symptomatic and 36 (42.4%) patients were asymptomatic. Out of the 49 symptomatic patients, 41 (48.2%) patients suffered from ischemic stroke, 8 (9.4%) patients experienced carotid TIA in the past 6 weeks prior to the intervention, 16 (18.8%) patients had lacunar infarcts, 11 (12.9%) patients had old strokes and 2 (2.4%) patients were diagnosed with dementia. A number of 28 (32,9%) patients suffered from EF < 50% and 57 (67,1%) patients had EF > 50%. Demographic data on age, sex, risk factors, type of intervention and type of ischemia prior to surgery are shown in Table 4.

Carotid stenosis was assessed by extracranial Doppler in 41 (48.2%) patients, AngioCT cervical region at 29 (34.1%) and all 85 patients performed cerebral/coronary/peripheral angiography being thus assessed the coronary and peripheral damage.

Patients with carotid artery damage of over 70% were: 47 (55.3%) patients with right ICA stenosis and 38 (44.7%) patients with left ICA stenosis, 33 (38.8%) patients had stenoses ranging from 70%-89% and 52 (61.2%) patients had ICA stenosis be-

TABLE 4. *Patient demographic date, vascular risk factors, type of intervention, type of ischemia before intervention*

	No. of patients	%
Age	85/ 64.02 +/-8.68	
Sex/Male/age	60/ 63.12 +/-8.85	70.6
Sex/Female/age	25/ 66.44 +/-7.93	29.4
Vascular risk factors		
Hypertension	83	97.6
Diabetes mellitus	31	36.5
Hyperlipemia	77	90.6
Smoking	56	65.9
Peripheral arterial disease	27	31.8
Obesity	21	24.7
Coronary disease	35	41.2
EF < 50% / EF > 50% TDV > 100 ml/TDV < 100 ml	28/57 40/45	32.9/67.1 47.05/52.95
CKD	22	25.9
Type of ischemia before CEA/CAS		
TIA/Major stroke (ranking > 2)	8/41	9.4/48.2
Asymptomatic	36	42.4
Hemiparesis/Motor aphasia	35/11	41.2/12.9
Lacunar stroke/Sequelae stroke	16/11	18.8/12.9
Type of intervention CEA/CAS	41/44	48.2/51.8

Note: ICA – internal carotid artery; CAS – carotid angioplasty stent;
CEA – carotid endarterectomy; TIA – transitory ischemic attack.
EF – Ejection fraction, CKD – chronic kidney disease, TDV – Telediastolic Volume

tween 90%-99% of which 38 (44.7%) patients had preocclusive stenosis about 95-99%. A number of 41 (48.2%) patients had CEA, 44 (51.8%) patients had CAS, and 3 (3,5%) patients had previous contralateral surgery. Moreover, 60 (70.6%) patients had contralateral carotid atheromatosis, 27 (31.7%) patients contralateral carotid stenosis over 50% of which 16 (18.8%) patients with stenosis between 50%-70% and 11 (12.9%) patients with stenosis between 70%-99%, 20 (23.5%) patients with contralateral occlusion, 10 (11.8%) patients with ipsilateral vertebral stenosis, 6 (7.1%) patients with contralateral vertebral stenosis, 8 (9.4%) patients with subclavian artery stenosis, 4 (4.7%) patients with renal artery stenosis. There were 35 (41.2%) patients with symptomatic coronary artery stenosis out of which 13 (15.3%) had heart attack and 22 (25.9%) with angina pectoris and the total number of patients with symptomatic/asymptomatic coronary stenosis was 32 (37.6%) patients with right coronary artery (RCA) stenosis, 22 (25.9%) patients with left circumflex artery (LCxA) stenosis and 28 (32.9%) patients with anterior descendent artery (ADA) stenosis. There were 24 (28.2%) patients with lower extremity artery stenosis.

Out of the 85 patients with severe carotid stenosis > 70%, 37 (43.5%) patients had only severe CaAS, 20 (23.5%) patients had CaAS and CoAS, 14 (16.5%) patients had CaAS and PAS and 14 (16.5%) patients had multiple organ damage (CaAS, CoAS, PAS). (Table 5)

From the 37 patients with only severe carotid stenosis, 28 were symptomatic ($p < 0.05$), 35 patients were hypertensive, 14 patients had diabetes, 11 had EF < 50%, 10 patients had contralateral occlusion and 3 patients presented severe stenosis of the contralateral ICA. A number of 22 patients had a stroke and 7 patients TIA ($p < 0.05$). Only 12 patients had CAS and 25 CEA ($p < 0.05$), and 2 patients had one intervention done in two steps at 1 month interval, CEA in two steps ipsi and contralateral symptomatic carotid stenosis. Four patients had organic vascular risk score (OVRS) more than 5.

Out of the 14 patients with multiple organ damage, 8 were asymptomatic, 5 patients had contralateral severe stenosis and 4 patients contralateral ICA occlusion, 7 patients had a stroke and 4 patients heart attack. There were seven interventions: 7 CEA and 7 CAS, two simultaneous CEA-CABG surgery, respectively one that was performed in two steps; 5 patients underwent bypass for the lower limbs and 4 patients at the coronary level and 13 patients had the organic vascular risk score (OVRS) more than 5.

From all patients presented, the proportion of surgery or percutaneous techniques was almost

equal, slightly higher for CAS versus CEA for both ipsi and contralateral stenosis in the case of bilateral lesions. Approximately half of the patients having carotid and coronary stenosis had simultaneously carotid and coronary interventions, surgical or percutaneous.

A quarter of all patients had surgery performed in two steps at intervals of one month in between the procedures, either carotid and coronary or carotid and peripheral. Also, a quarter of the patients with multiple organ damage with high GCVHRS and OVRS had an intervention done in three steps at intervals of several months in between the procedures.

From the patients with only severe carotid stenosis, two thirds had CEA and one third had CAS, while for the severe carotid and coronary stenosis and those with severe carotid and peripheral stenosis, two thirds had CAS and one third had CEA.

Stroke was present in two thirds of the patients having only carotid problems, and it was also present in about half of the patients with carotid and coronary or carotid and peripheral stenosis. Myocardial infarction was present for approximately half of the patients with coronary and carotid stenosis and for a quarter of the patients with multiple organ damage.

GCVHRS was higher in patients with carotid and coronary problems followed by patients with multiple organ damage compared with patients with only carotid stenosis or carotid and peripheral stenosis. OVRS was higher in patients with global organ damage compared to other groups of patients that were studied. EF degrease with the degree of carotid stenosis, if coronary and/or peripheral involvement coexisted. TDV increase in patients with multiple organ problems compared to the other groups of patients that were studied.

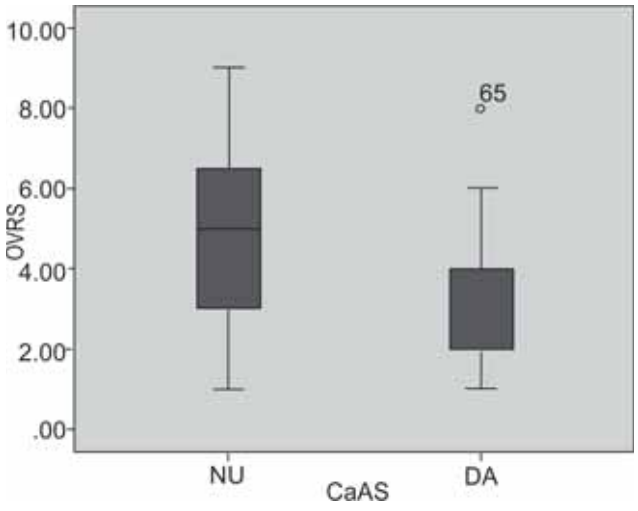

FIGURE 1. *Graphic representation by box plots of OVRS for patients with only carotid problems*

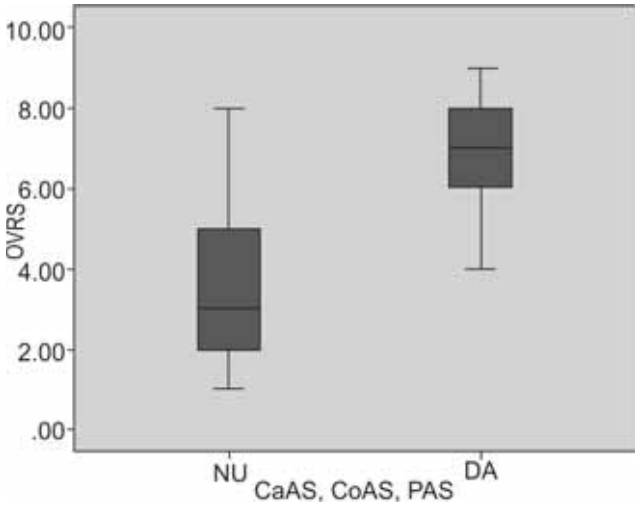

FIGURE 2. *Patients with overall problems (carotid, coronary and peripheral)*

Score BP, GCVHRS and OVRS were significantly higher for both carotid and coronary patients as well as for those who had overall problems com-

TABLE 5. *Risk scores, EF, TDV for the 4 types of patients: CaAS; CaAS and CoAS; CaAS and PAS; CaAS and CoAS and PAS.*

	Study patients				Matched patients
Arterial stenosis	CaAS	CaAS and CoAS	CaAS and PAS	CaAS and CoAS and PAS	
no	37	20	14	14	85
%	43.5	23.5	16.5	16.5	100
GCVHRS	4.29 +-2.09*	5.80 +/-2.33*	4.78 +/-1.12	5.64 +/-1.64	2.01 +/-1.17
OVRS	2.97 +/-1.57*	4.80 +/-1.60	3.71 +/-1.72	6.78 +/-1.42*	
Score BP	3.59 +/-0.55*	4.00 +/-0.01*	3.50 +/-0.65	4.00 +/-0.01*	2.16 +/-1.01
EF	52.27 +/-7.56	48.5 +/-7.79	51.78 +/-8.45	45.71 +/-13.56	57.88 +/-3.39
TDV	92.13 +/-30.27*	106.55 +/-24.16	108.42 +/-37.02	124.28 +/-51.38	

*p < 0.05

Note: CaAS – Carotid artery stenosis; CoAS – Coronary artery stenosis; PAS – Periferal artery stenosis; Score BP – Score blood preasure; GCVHRS – Global cardiovascular and hemodynamic risk score; OVRS – Organic vascular risk score; EF – Ejection fraction; TDV – Telediastolic volume

TABLE 6. *Statistical significance of the Score BP, GCVHRS, SROV in patients with carotid and coronary, carotid and peripheral problems and those with overall problems as compared to patients who only had carotid problems*

	CaAS versus CaAS and CoAS	CaAS versus CaAS and PAS	CaAS versus CaAS and CoAS and PAS
Score BP	P = 0.002*	P = 0.605	P = 0.006*
GCVHRS	P = 0.016*	P = 0.413	P = 0.010*
OVRS	P = 0.000*	P = 0.150	P = 0.000*

*p < 0.05

Note: CaAS – Carotid artery stenosis; CoAS – Coronary artery stenosis; PAS – Periferal artery stenosis, Score BP – Score blood preasure; GCVHRS – Global cardiovascular and hemodynamic risk score; OVRS – Organic vascular risk score;

paring to those who only had carotid problems (p < 0.05).

Higher composite scores (GCVHRS and OVRS) and decrease of EF best correlated with: the degree of carotid stenosis (p < 0.05), with the presence of left internal carotid involvement, with the presence of a contralateral involvement (stenosis/occlusion) (p < 0.05).

Regarding the type of intervention, GCVHRS was higher in patients undergoing simultaneous (CAS and coronary stent) compared to those who have done intervention in two steps (CEA and a coronary stent).

SROV was higher in patients who have done in two steps intervention (CEA and a coronary stent or two CAS ipsi and contralateral) compared to those who have done (two CEA ipsi and contralateral) and higher in patients who have undergone this intervention in three steps (CEA and coronary stents).

EF decrease in patients with CAS than in those with CEA and decrease in those who had simultaneously (CEA and CABG) or in two steps (CEA and a coronary stent) compared to the other interventions CEA, respectively CAS ipsi and contralat-

TABLE 8. *Prognostic factors in patients with severe CaAS and/or multiple organ damage that were candidates for CEA or CAS. depending on risk factors. degree of stenosis/occlusion. and risk scores. OR – odds ratio; CI – confidence interval*

Risk patients:		OR	95% CI	p-value
CaAS CaAS and PAS	Dyslipidemia	10.33 9.78	3.17-37.02 1.24-76.67	< 0.001 0.030
CaAS CaAS. CoAS and PAS	Smoking	7.42 10.71	2.75-20.02 2.31-41.59	< 0.001 0.002
CaAS and CoAS	CKD	8.1	2.67-24.5	< 0.001
CaAS and CoAS	EF < 50%	3.21	1.04-9.96	0.043
CaAS CaAS and CoAS CaAS. CoAS and PAS	Stenosis 50-70% ICA contralateral Stenosis > 70% ICA contralateral Peripheral damage	3.95 17.44 127.48	1.23-12.71 1.11- 273.83 7.40-2195.13	< 0.001 0.004 0.001
CaAS CaAS and CoAS	Occlusion	15.24	3.86-60.09	0.005
CaAS	Score BP > with 1 point	Increases 5.09	2.33-11.09	< 0.001
CaAS CaAS and CoAS	GCVHRS > with 1 point	Increases 1.95 Increases 1.31	1.21-3.14 1.01-1.70	< 0.001 0.038
CaAS. CoAS and PAS	OVRS > with 1 point	Increases 2.64	1.64-4.24	< 0.001
CaAS	EF > with 1 point	Decreases 0.71	0.61-0.83	< 0.001
CaAS and CoAS	Stenosis RCA	7.27	1.85-28.60	0.004
CaAS and CoAS	Stenosis ADA	11.32	3.07-41.72	< 0.001
Stroke	Dyslipidemia Coronary Carotid and peripheral	10.75 66.32 117.60 83.90	3.63-31.82 8.26-532.01 14.72-939.16 8.99-782.38	< 0.001 < 0.001 < 0.001 < 0.001
Myocardial infarction	EF < 50% Multiple organ damage Subclavian stenosis EF > with 1 point	16.34 69.15 45.34 Scade 0.86	4.58-58.29 1.28-3719.23 1.48-1381.58 0.77-0.95	< 0.001 0.003 0.020 0.004

P < 0.005

Note: ICA – internal carotid artery; CAS – carotid angioplasty stent; CEA – carotid endarterectomy; CABG – Coronary artery bypass graft; TIA – transitory ischemic attack. CKD – chronic kidney disease; CaAS – Carotid artery stenosis; CoAS-Coronary artery stenosis; PAS – periferal artery stenosis; Score BP – Score blood preasure; GCVHRS – Global cardiovascular and hemodynamic risk score; OVRS – Organic vascular risk score; EF – Ejection fraction; TDV – Telediastolic volume; RCA – Right Coronary Artery; ADA – Anterior Descendent Artery.

eral to stenosis at an interval of approximately one month.

DISCUSSIONS

Higher composite scores (SRCVGH and SROV) and decrease of EF statistically best correlated with: coronary disease, ischemic stroke and CAS intervention ($p < 0.05$). Carotid Revascularization Endarterectomy versus Stenting Trial (CREST) was the only study comparing CEA and CAS in patients with asymptomatic and symptomatic carotid stenosis that showed equal risk infarction, or death. There was a higher risk of ischemic stroke with CAS and a higher risk of myocardial infarction with CEA during the periprocedural period. (11)

GCVHRS was higher in patients with EF < 50%. Other studies showed that patients with EF of 35% are at increased risk for perioperative cardiac complications following CEA and reduced overall survival (12).

In our group the preferred procedure for severe bilateral carotid stenosis was stenting (CAS) in a two time approach, if coronary and/or peripheral involvement coexisted. One study shows that CAS is a safe and dependable method of carotid revascularisation when offered as an

Composite scores were higher in patients that underwent a surgical procedure (CEA and CABG) than percutaneous (CAS and coronary stent) in a two step approachs. A meta-analyses (14,15) that compared CAS and CEA treatment of patients with symptomatic carotid artery stenosis indicated that patients who received CAS had a significantly increased risk of 30-day mortality or stroke compared with patients who received CEA (OR = 1.60; CI 1.26–2.01) and concluded that CEA should remain the first intervention in symptomatic patients. The recommendations for interventions on carotid artery stenosis in selected patients should be considered in CAS and CEA centers with low periprocedural complication rates.(16).

Depending on the studied risk factors (hypertension, smoking, diabetes, CKD, dyslipidemia and EF </> 50%), the risk of severe carotid damage significantly increases in dyslipidemic patients compared to those with a normal cholesterol (OR =10.33, 95% CI 3.17-37.02, $p < 0.001$). Also the risk of carotid artery and coronary damage is significantly higher in smoking versus non smoking patients (OR = 3.40, 95% CI 1.08-10.70, p = 0.036), in patients with CKD compared to those without CKD (OR = 8.1, 95% CI 2.67-24.5, $p < 0.001$) and in patients with EF < 50% compared to those with EF > 50% (OR = 3.21, 95% CI 1.04-9.96, p = 0.043). The risk of multiple organ vascular damage is significantly increased (OR = 10,71 95% CI-2,31-41,59, p = 0,002) in smoking versus non-smoking patients. One study shows that in patients with asymptomatic carotid stenosis and no history of carotid disease, who have peripheral vascular disease or diabetes the risk of cardiac events is similar if patients have a history of carotid stenosis (17).

Out of the 170 studied patients, according to the type of stenosis/occlusion, the risk of severe carotid damage increases significantly in patients with stenosis 50-70% of ACI contralateral (OR = 3.95 95% CI 1.23-12.71, $p < 0.001$), respectively in patients with occlusion of ICA contralateral (OR = 15.24, 95% CI 3.86-60.09, p = 0.005) as compared to those with no stenosis/occlusion of the ICA contralateral. Roederer et al. estimated the risk of ischemic stroke or carotid occlusion at 46% per year in patients with asymptomatic carotid stenosis greater than 80%. (18)

The risk of carotid and coronary damage is significantly higher in patients with stenosis of RCA (OR = 7.27, 95% CI 1.85-28.60, p = 0.004), respectively in patients with stenosis of ADA (OR = 11.32, 95% CI 3.07 - 41.72, $p < 0.001$) as compared to patients without stenosis RCA or ADA. One study shows that patients with asymptomatic/ symptomatic cerebrovascular disease present an increased risk of myocardial infarction and cardiac death and those with symptomatic carotid stenosis > 50% have a coronary risk and should be considered for cardiac screening (19,20).

The risk of suffering an ischemic stroke, according to the risk factors, is significantly increased by (OR = 10.75, 95% CI 3.63-31.82, $p < 0.001$) in dyslipidemic patients compared to those with a normal cholesterol. Also in coronary patients compared to non-coronary patients the risk of suffering an ischemic stroke is significantly increased (OR = 66.32 95% CI 8.26 - 532.01, $p < 0.001$) and those with carotid and peripheral damage compared to other patients have a risk of suffering an ischemic stroke of (OR = 83.90 95% CI 8.99 - 782.38, $p < 0.001$) and those with only carotid damage compared to another organ damage have a risk of suffering a stroke of (OR = 117.60 95% CI, 14.72 -939, 16, $p < 0.001$). One study shows that patients with carotid stenosis greater than 75% have a 26% risk of stroke in three years. (21)

The risk of suffering a heart attack according to risk factors is significantly increased by an (OR = 16.34 95% CI 4.58 - 58.29, $p < 0.001$) in patients

with EF < 50% compared to those with EF > 50%, by an (OR = 69.1595% CI 1.28 - 3719.23, p = 0.03) in patients with multiple organ damage (carotid, coronary and peripheral) compared to those without organ damage, respectively by an (OR = 45.34 95% CI 1.48-1381.58, p = 0.02) in patients with subclavian stenosis compared to those with non-subclavian stenosis.

Each percentage unit increase in EF , decreases the risk of suffering a heart attack with a odd ratio OR of 0,86. A meta-analysis published by Touzè et al. included 39 studies and a mean follow-up of 3.5 years after a TIA and an ischemic stroke and the annual risk of a myocardial infarction was 2.2%. (22)

CONCLUSIONS

Higher composite scores (GCVHRS and OVRS) and decrease of EF best correlated with: the degree of carotid stenosis, with the presence of left internal carotid involvement, with the presence of a contralateral involvement (stenosis/occlusion). Also these scores were higher in patients that underwent an interventional treatment either CAS or CEA or CEA and coronary stenting generally in a two step approachs. In our group the preferred procedure for severe bilateral carotid stenosis was stenting (CAS) in a two time approach, if coronary and/or peripheral involvement coexisted.

Secondary vascular disease prevention is mandatory in patients with carotid, coronary and peripheral arterial disease. A composite vascular risk evaluation is useful for individually tailoring our interventional treatment strategy thus improving the global functional outcome of any given patient.

REFERENCES

1. **Bhatt D.L., Steg P.G., Ohman E.M., Hirsch A.T., Ikeda Y., Mas J.L., Goto S., Liau C.S., Richard A.J., Rother J., Wilson P.W**. International prevalence, recognition, and treatment of cardiovascular risk factors in outpatients with atherothrombosis. *JAMA* 2006; 295: 180-9.
2. **Rothwell P.M., Villagra R., Gibson R., Donders R., Warlow C.P.** Evidence of a chronic cause of instability of atherosclerotic plaques. *Lancet* 2000; 355: 19-24.
3. **Chaturvedi S., Bruno A., Feasby T., et al.** Carotid endarterectomy—an evidence based review: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology* 2005; 65:794-801.
4. **Hankey G.J., Slattery J.M., Warlow C.P.** Transient ischaemic attacks: which patients are at high (and low) risk of serious vascular events? *J Neurol Neurosurg Psychiatry* 1992; 55: 640-52.
5. **North American Symptomatic Carotid Endarterectomy Trial Collaborators**. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 1991; 326:445-53.
6. **Halliday A., Mansfield A., Marro J., et al.** Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: randomized control trial. *Lancet* 2004; 363:1491-502.
7. **Adams R.J., Albers G., Alberts M.J., et al.** Update to the AHA/ASA recommendations for the prevention of stroke in patients with stroke and transient attack. *Stroke* 2008; 39:1647-52.
8. **Brott T.G., Hobson R.W. 2nd, Howard G., et al.** Stenting versus endarterectomy for treatment of carotid-artery stenosis. *N Engl J Med* 2010; 363:11-23.
9. **H. Poppert, S. Sadikovic, K. Sander, O. Wolf and D. Sander** Embolic signals in unselected stroke patients: prevalence and diagnostic benefit, *Stroke*, vol. 37, no. 8, pp. 2039-2043, 2006.
10. **Roman Komorovsky Alessandro Desideri**. Carotid ultrasound assessment of patients with coronary artery disease: a useful index for risk stratification, Cardiovascular Research Vascular Health and Risk Management 2005:1(2) 131-136.
11. **T. G. Brott, R.W. Hobson, G. Howard et al**., "Stenting versus endarterectomy for treatment of carotid artery stenosis," *New England Journal of Medicine*, vol. 363, no. 1, pp. 11-23, 2010.
12. **Kazmers A., Cerqueira M.D., Zierler R.E.** The role of preoperative radionuclide left ventricular ejection fraction for risk assessment in carotid surgery. *Arch Surg* 1988; 123:416-419.
13. **Joanna P. Ti, David Carmody, Sarah Power, Alison Corr, Joan Moroney, David Williams, Seamus Looby, Alan O'Hare, John Thornton, Paul Brennan**. Our Single-Centre Experience of Carotid Artery Stenting in High-Risk Patients over a 10-year period, The eJournal of the European Society of Minimally Invasive Neurological Therapy, 2013: 1346000132; 1-14.
14. **P.A. Ringleb, G. Chatellier, W. Hacke et al**., Safety of endovascular treatment of carotid artery stenosis compared with surgical treatment: a meta-analysis, *Journal of Vascular Surgery*, vol. 47, no. 2, pp. 350-355, 2008.
15. **J. Ederle, R.L. Featherstone, and M.M. Brown**. Randomized controlled trials comparing endarterectomy and endovascular treatment for carotid artery stenosis a cochrane systematic review, *Stroke*, vol. 40, no. 4, pp. 1373-1380, 2009.
16. **Arijana Lovrencic-Huzjan, Tatjana Rundek, Michael Katsnelson** Recommendations for Management of Patients with Carotid Stenosis Hindawi Publishing Corporation Stroke Research and Treatment Volume 2012, Article ID 175869, 12 pages doi:10.1155/2012/175869.
17. **Chimowitz M.I., Weiss D.G., Cohen S.L., et al.** Cardiac prognosis of patients with carotid stenosis and no history of coronary artery disease: Veterans Affairs Cooperative Study Group Stroke 1994; 25:759-765.
18. **Roederer G.O., Langlois Y.E., Jager K.A., Primozich J.F., Beach K.W., Phillips D.J., et al.** The natural history of carotid arterial disease in asymptomatic patients with cervical bruits. *Stroke.* 1984; 15(4):605-13.
19. **Chaturvedi S.** Should stroke be considered both a brain attack and a heart attack? *Stroke* 2007; 38:1713-1714.
20. **Adams R.J., Chimowitz M.I., Alpert J.S., Awad I.A., Cerqueria M.D., Fayad P., Taubert K.A.** Coronary risk evaluation in patients

with transient ischemic attack and ischemic stroke. A scientific statement for healthcare professionals from the Stroke Council and the Council on Clinical Cardiology of the American Heart Association/ American Stroke Association. *Circulation* 2003; 108:1278-1290.

21. **Chambers B.R., Dinnan G.A.** Carotid endarterectomy for asymptomatic carotid stenosis. Cochrane Database Syst Rev. 2005; 19(4)
22. **Touzé E., Varenne O., Chatellier G., Peyrard S., Rothwell P.M., Mas J.L.** Risk of myocardial infarction and vascular death after transient ischemic attack and ischemic stroke: a systematic review and meta-analysis. *Stroke* 2005 36:2748-2755.