

## DEVELOPMENT OF POSTOPERATIVE INTERNAL CAROTID ARTERY OCCLUSION DUE TO THE PRESENCE OF RISK FACTORS

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**SUMMARY** – Postoperative internal carotid artery (ICA) occlusion is a rare condition with few data on the risk factors. The aim of the study was to analyze risk factors and ischemic symptomatology in patients with postoperative ICA occlusion. During one year period, 33 patients with postoperative ICA occlusion were examined at Cerebrovascular Laboratory. Medical history, clinical findings and atherosclerosis risk factors were compared with data on 33 patients with satisfactory postoperative finding. Student's *t*-test was used on data comparison ( $P < 0.05$ ). In 31 of 33 patients, ICA occlusion was recorded on the first postoperative examination, 3 months after carotid endarterectomy (18 right and 15 left). In 8 patients, combined occlusion of the common carotid artery and ICA was found (4 right, 4 left). One patient ICA developed occlusion during the first and third postoperative year each. Clinically, three patients presented with ischemic symptoms (one stroke and two transitory ischemic attacks (TIA)). The following risk factors were present in the group with postoperative ICA occlusion: hypertension in 18, smoking in 10, hyperlipidemia in 8, diabetes mellitus in 9, history of stroke in 13, TIA in 3, heart attack in 4 and coronary disease in 3 patients; the respective figures in the control group were as follows: 25, 11, 16, 7, 7, 3, 4 and 3. There was no significant between-group difference in the presence of risk factors. Study results suggested that postoperative ICA occlusion was not caused by atherosclerosis risk factors but by perioperative complications.

**Key words:** *Carotid stenosis – risk factors; Carotid stenosis – surgery; Endarterectomy, carotid – adverse, effects; Endarterectomy, carotid – complications; Cerebrovascular accident – complications*

### Introduction

Cerebrovascular diseases are among most common diseases in the world (around 33% of the population), especially in developing countries. They are the second cause of death and the leading cause of disability<sup>1</sup>. In Croatia, stroke was the leading cause of death in

women (19%) and the second most common cause of death in men (13%) in 2007<sup>2</sup>.

Carotid atherosclerosis is a well known risk factor for stroke. Around 50% of stroke incidents are linked to atherosclerotic changes of extra- or intracranial arteries. Carotid endarterectomy (CEA) is a safe and efficient method in primary and secondary prevention of stroke<sup>3-6</sup>. Short-term benefit of this procedure depends on perioperative complications and mortality, which combined have to be below 5%<sup>6</sup>. Restenosis after CEA is relatively rare, total risk of resteno-

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sis (above 60% diameter reduction) ranges between 13% and 21%<sup>7</sup>, and even if it develops, it is usually asymptomatic. If the restenosis is significant, in most hospitals patients undergo second CEA. Significant restenosis holds a great risk of progression to occlusion, and the risk of stroke from a carotid occlusion can be as high as 9%<sup>8</sup>. Prevention of carotid occlusion is therefore a tool in stroke prevention.

Restenosis usually develops early, within 2 years after surgery. The process involved in early restenosis is myointimal hyperplasia. If restenosis develops after a longer period of time, it is usually caused by well established atherosclerosis risk factors that caused the original disease. A 5-year follow up study has shown the incidence of both residual and recurrent carotid stenosis to be 13%<sup>7</sup>, with the majority of restenoses being asymptomatic<sup>9</sup>.

## Patients and Methods

During one-year period, 8000 patients were examined at Cerebrovascular Laboratory by use of carotid color coded flow imaging (CCDFI). Among them there were 297 (3.7%) patients with occlusion of the internal carotid artery (ICA). Thirty three (0.4%) patients developed occlusion after CEA. There was a predominance of male patients (75.7%) and mean age of 68.7 (age range 50-85) years.

Data on 33 consecutive patients with a satisfactory postoperative finding were analyzed to serve as a control group. There was also a slight male predominance (69.7% male) and mean age of 70.7 (age range 53-83) years.

Follow up examinations were conducted by use of color-doppler ultrasound on ALOKA 5500 and  $\alpha$ 10 Premium, with a 10-MHz linear probe. The morphology of carotid plaque and the grade of stenosis

were analyzed according to the well defined criteria<sup>10</sup>. Stenosis (as well as restenosis) of the carotid artery was categorized as follows: mild stenosis (reduction of diameter below 50%), moderate stenosis (51%-75% reduction), and significant stenosis (reduction over 75%). Occlusion of carotid artery was diagnosed when carotid artery was filled with plaques, and no color-coded flow or hemodynamic spectrum was recorded. Patient history and data on vascular risk factors were collected retrospectively. Comparison of risk factors in patients with and without postoperative occlusion was performed by Student's *t*-test.

## Results

The patient demographic data are shown in Table 1. Postoperative occlusion of ICA (75.7%) was recorded in 11 patients on the left side and in 14 patients on the right side. Combined occlusion of the common carotid artery and ICA occurred in 8 (24.3%) patients, 4 on either side. Contralateral carotid artery showed non-significant atherosclerotic changes in 27 (82%) patients, of which 8 had undergone previous CEA. Five (15%) patients had moderate ICA stenosis and one (3%) patient had subtotal ICA stenosis. Duplex scanning demonstrated ICA occlusion on the first follow up examination taken at 3 months of the procedure in 31 (94%) patients, and during the first and third year of follow up in one (3%) patient each. Three (9%) patients presented with ischemic symptoms during the first postoperative days (transient ischemic attacks (TIA) in two patients and stroke in one patient).

In the group with satisfactory postoperative finding, 17 patients had surgery on the right side, 12 on the left, and 4 patients had bilateral CEA. Contralaterally, 25 (76%) patients had non-significant athero-

Table 1. Demographic data on patients with postoperative occlusion and control group

Patients	Postoperative occlusion (n=33)	Satisfactory postoperative finding (n=33)
Sex	25 male/8 female	23 male/10 female
Age (yrs; mean $\pm$ SD)	68.7 $\pm$ 7.2	70.7 $\pm$ 7.2
Age at time of surgery (yrs)	65.6	65.8
Median postoperative follow-up (yrs)	3.8	4.4
Side of carotid endarterectomy	18 right/15 left	21 right/16 left

Table 2. Vascular risk factors in patients with postoperative occlusion and control group

Patients	Postoperative occlusion (n=33)	Satisfactory postoperative finding (n=33)
Hypertension	25 (75.7%)	18 (54.5%)
Smoking	11 (33.3%)	10 (30%)
Hyperlipidemia	16 (48.5%)	8 (24.2%)
Diabetes mellitus	7 (21.2%)	9 (27.3%)
History of stroke	7 (21.2%)	13(39.3 %)
History of transient ischemic attack	3 (9%)	3 (9%)
History of heart attack	4 (12%)	4 (12%)
Coronary disease	3 (9%)	3 (9%)

sclerotic changes, 6 (18%) patients developed moderate ICA stenosis, and 2 (6%) patients had occlusion of the contralateral carotid artery.

The presence of vascular risk factors (hypertension, smoking, hyperlipidemia, diabetes mellitus, history of stroke, TIA, history of heart attack and coronary disease) was analyzed in both groups of patients. These results are shown in Table 2. There was no significant between-group difference in the presence of risk factors ( $P=0.55$ ).

## Discussion

Our data showed postoperative occlusion of ICA to develop early after surgery. In 31 of 33 (94%) study patients, it was detected on the first follow up examination that took place 3 months after the procedure. In one patient, occlusion developed during the first postoperative year, and in another one during the third year of follow up.

In the literature, the incidence of recurrent carotid stenosis has been reported to be between 1% and 41%, while postoperative occlusion occurs in less than 1% of patients<sup>9,11</sup>. Results of the CAVATAS study have shown the rate of significant carotid restenosis to be 4% and of carotid occlusion 1.1% one year after CEA<sup>12</sup>.

Early after surgery, local factors (local microtrauma, inflammation) play a major role in the development of carotid occlusion. Recognized risk factors for postoperative occlusion of ICA were smoking, smaller diameter of ICA, defects found during surgery, and certain genotypes<sup>9</sup>. Systematic risk factors such as hypertension, hyperlipidemia, diabetes mellitus, obesity

and smoking increase the risk of developing late occlusion, which occurs at least 2 years after the procedure. Diabetes mellitus has been reported as a risk factor for postoperative carotid occlusion<sup>13</sup>, and also as a predictive factor for the risk of perioperative stroke or death (in 30-day period after surgery)<sup>14</sup>. However, other authors did not find diabetes mellitus patients to be at a greater risk after CEA<sup>15</sup>. The prevalence of diabetes mellitus in the Croatian population (aged 18–65) is 6.1%, and in the elderly it is 8.9%<sup>16</sup>. In our study patients, the prevalence of diabetes was 27.3%, which was several fold that in the general population. Age over 80 is also a risk factor for perioperative complications<sup>14</sup>. Only one of our patients in the group with postoperative occlusion was in this age group (age 85). Younger age is also mentioned as a risk factor<sup>17</sup>, which could be explained by a more malignant form of atherosclerosis present in younger patients. Female sex has been described as a risk factor<sup>13,17</sup>, possibly because of the naturally narrower lumen of the carotid artery. Although vascular risk factors were present in a high percentage in the group with postoperative occlusion as compared with the general population, there was no significant difference from the control group.

Three of 33 patients with postoperative ICA occlusion presented with ischemic symptoms after developing carotid occlusion (one with stroke and two with TIA). The incidence of ischemic symptoms in postoperative ICA occlusion is low, between 1% and 4%<sup>7,17</sup>. Previous studies have shown a 5-fold risk of progression of contralateral carotid artery stenosis from moderate to significant after CEA. In our patients, moderate stenosis of the contralateral carotid artery was found in 6 of 33 (18%) patients and contralateral ICA

occlusion in 2 (6%) patients. Moderate stenosis (above 50%) of contralateral carotid artery is considered to be a risk factor for perioperative stroke or death<sup>14</sup>, hence the need for yearly postoperative follow up examinations recommended in the guidelines<sup>18</sup>.

In conclusion, postoperative carotid occlusion is rare and mostly asymptomatic. It is caused by perioperative complications. However, these patients are at a higher risk of contralateral carotid disease progression and have to be monitored regularly.

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## Sažetak

## RAZVOJ POSLIJEOPERACIJSKE OKLUZIJE KAROTIDNE ARTERIJE ZBOG PRISUTNOSTI RIZIČNIH ČIMBENIKA

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Poslijeoperacijska okluzija unutarnje karotidne arterije je rijetka komplikacija s nedovoljno poznatim rizičnim čimbenicima. Cilj ove studije bio je analizirati čimbenike rizika ateroskleroze i simptome ishemijske kod bolesnika s okluzijom karotidne arterije nakon karotidne endarterektomije. Tijekom godine dana je u u Cerebrovaskularnom laboratoriju pregledano 33 bolesnika s poslijeoperacijskom okluzijom unutarnje karotidne arterije. Uzeti su anamnestički podaci, analizirana je klinička slika, te čimbenici rizika ateroskleroze. Podaci su uspoređeni s podacima 33 bolesnika sa zadovoljavajućim poslijeoperacijskim nalazom. Podaci su uspoređeni Studentovim t-testom. U 31 od 33 bolesnika okluzija je ustanovljena tijekom prvog pregleda 3 mjeseca nakon karotidne endarterektomije, u troje bolesnika uz pojavu ishemijske simptomatologije. U 8 bolesnika zabilježena je poslijeoperacijska okluzija cijelog karotidnog stabla. U jednog je bolesnika okluzija nastala tijekom prve godine praćenja, dok je u jednog nastupila nakon tri godine. Čimbenici rizika ateroskleroze u skupini s poslijeoperacijskom okluzijom su bili: hipertenzija u 18, pušenje u 10, hiperlipidemija u 8, dijabetes melitus u 9, preboljeli moždani udar u 13, preboljela TIA u 3, infarkt miokarda u 4, angina pektoris u 3 bolesnika, dok su u skupini sa zadovoljavajućim poslijeoperacijskim nalazom to bili: hipertenzija u 25, pušenje u 11, hiperlipidemija u 16, dijabetes melitus u 7, preboljeli moždani udar u 7, preboljela TIA u 3, infarkt miokarda u 4, angina pektoris u 3 bolesnika. Nije bilo značajne razlike u prisutnim čimbenicima rizika. Dakle, rana poslijeoperacijska okluzija karotidne arterije najvjerojatnije nije uzrokovana uobičajenim čimbenicima rizika ateroskleroze, nego periproceduralnim komplikacijama.

*Ključne riječi: Karotidna stenoza – rizični čimbenici; Karotidna stenoza – kirurgija; Endarterektomija, karotida – štetni učinci; Endarterektomija, karotida – komplikacije; Cerebrovaskularni ispad – komplikacije*