The Effect of Severe Contralateral Carotid Stenosis or Occlusion on Early Outcomes after Carotid Endarterectomy


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Abstract:

BACKGROUND: Stenosis of the carotid arteries, as a consequence of atherosclerosis, is the most common cause of cerebrovascular insult (CVI). Severe (>70%) contralateral stenosis or occlusion (SCSO) of the carotid artery may represent an additional pre-operative risk factor for neurologic incidents.

AIM: The aim of this study was to confirm and compare early perioperative results (0–30 days) of carotid endarterectomy (CEA) in patients with and without SCSO.

RESULTS: A total of 273 CEA were performed, divided into two groups: SCSO groups 40 (14.7%) and non-SCSO group 233 (85.3%). Between the two groups, a statistically significant difference between patients was found (54.1% compared to 87.5%; p<0.0005), CEA with patch angioplasty (25.3% compared to 52.5%; p = 0.01), and CEA with the use of a shunt (3.9% compared to 35%; p<0.0005) in favor of the SCSO group. There was no statistically significant difference (SCSO was not identified as a risk factor) for any type of stroke or mortality. Logistically regression confirmed SCSO to be an independent predictor of 30-day mortality (OR: 21.58; 95% CI: 1.27–36.3; p = 0.033) and any type of stroke or mortality (OR: 9.27; 95% CI: 1.61–53.22; p = 0.012). SCSO was not a predictor of any type of stroke within 30 days. Predictors of any type of stroke were dyslipidemia (OR: 0.12, 95% CI: 1–0.02; p = 0.024).

CONCLUSIONS: There was no statistically significant difference in the incidence of early (30 day) perioperative complications between the analyzed groups. The percentage of perioperative complications remains within the accepted parameters, and thus, SCSO should not be qualified as a significant risk factor for CEA. We are of the opinion that CEA remains a safe and acceptable option for patients with SCOSO, and SCOSO should not be a reason for preferential use of carotid stenting.

Introduction

Cerebrovascular insult (CVI) as a consequence of atherosclerotic disease of the carotid arteries (stenosis and occlusion) is the third most common cause of death in developed countries. It is the most common neurologic diagnosis requiring hospitalization [1] and the leading cause of long-term disability [2].

Carotid endarterectomy (CEA), according to the most recent guidelines, remains the recommended “gold standard” in treating symptomatic stenosis of the carotid arteries (50–99%) and prevention of cerebrovascular events [3], [4], [5], [6]. Reported outcomes of severe (>70%) contralateral carotid stenosis or occlusion (SCSO) on perioperative and long-term results of CEA differ in the previous studies. The North American Symptomatic Carotid Endarterectomy Trial (NASCET) reported on the increased risk of perioperative stroke after CEA, in patients with contralateral occlusion of carotid arteries [7], [8]. Surgical intervention, in the aforementioned study, had increased benefits compared to conservative (pharmacologic) treatment, despite the increased perioperative risks. Further analysis of studies regarding asymptomatic carotid atherosclerosis (ACAS) showed that CEA in an asymptomatic patient with contralateral carotid occlusion does not provided long-term benefits in prevention of stroke and death (medical vs. surgical treatment group, 3.5% vs. 5.5%; p = 0.58) [9].

Several multicenter studies indicated that SCOSO is a risk factor for poor outcome after CEA [10], [11], [12], [13]. Other studies reported an insignificant larger risk of stroke in patients with contralateral carotid disease [14], [15] while many single-center studies reported about the comparable perioperative results for both groups [16], [17], [18], [19], [20].

The goal of this study was to confirm and compare early perioperative results (0–30 days) CEA in patients with and without SCOSO.

1642 https://oamjms.eu/index.php/mjms/index
Patients and Methods

In this retrospective study, 249 patients were included, which underwent CEA due to stenosis of the carotid arteries, in the period from May 1, 2017, to January 31, 2022, in the Clinic for Cardiovascular surgery at the University Clinical Centre of Sarajevo. Patients were divided into two groups: A non-SCSO group (n = 233) in which patients without stenosis of the contralateral internal carotid artery, as well as those with mild (<50%) or moderate (50%–70%), disease of the contralateral carotid arteries. The SCSO group (n = 40) included those patients with severe stenosis (70%–89%), very severe stenosis (90%–99%), or occlusion of the contralateral internal carotid artery.

Our study was conducted in accordance with the Helsinki Declaration of 1975; informed consent was attained from all our patients.

Patients were considered symptomatic if they had transient ischemic attacks, amaurosis fugax, or non-disabling stroke which is ipsilateral compared to the site of significant carotid stenosis of the past 6 months.

In patients with bilateral carotid stenosis, the choice of carotid artery, which was first surgically treated, was conducted according to the following criteria, presence of neurologic symptoms, degree of carotid stenosis, and presence of asymptomatic cerebral infarction.

We gather the following variables for each patient: Age, gender, history of hypertension (HTN), hyperlipidemia (HLP), diabetes mellitus (DM), smoking status, and presence of coronary artery disease (CAD) which was not surgically treated, presence of peripheral arterial disease (PAD), status of symptoms, and details regarding the CEA technique (eversion or classic), type of anesthesia (local or general), and the use of a shunt. Of the post-operative complications, we analyzed the total number of CVI, mortality, and CVI/mortality.

Patients were surgically treated in regional anesthesia, or alternatively, in general anesthesia whenever local anesthesia was not suitable. CEA was conducted with the eversion and classic technique with patch plasty (Dacron patch), along with selective use of shunts.

In patients operated under regional anesthesia, shunts were used according to the level of consciousness and motor function after brief clamping of the carotid artery. Tests for evaluating the degree of consciousness including having the patient count numbers, and motor function was examined by having the patient squeeze rubber toys with the contralateral hand. Following this evaluation, carotid shunts were immediately placed following auditory or motor dysfunction. In the event that pressure in the ICA was lower than 40 mmHg following clamping, shunts were used in patients operated on under general anesthesia [21].

Degree of stenosis was determined by Doppler ultrasound and CT angiography or MR angiography. The source of data was the computerized database and charts of disease history of hospitalized patient records.

Technique eversion CEA entailed transection at the level of the carotid bifurcation with the removal of atherosclerotic plaque distal displacement artery, followed by removal of plaque from the ACC and ACE anatomical reimplantation of ACI.

Classical CEA technique performed with longitudinal arteriotomy of the ACI and ACC and removal of atherosclerotic plaque. Arteriotomy was closed using prosthetic patch. For this study, patients were followed 30 days after the operation.

The inclusion criteria for the study were as follows: Patients with restenosis of the carotid artery, stenosis of the carotid artery with accompanying stenosis of the aortic branches, dissection of the carotid arteries, aneurysm of the carotid arteries, simultaneous CEA operation, and aortic-coronary bypass or peripheral revascularization.

Thirty-day complications were followed in all patients, including all types of stroke, death, and stroke/mortality. Postoperatively, neuroimaging was conducted in only those patients who had neurologic deficits.

Statistical analysis

Basic characteristics of our study were attained and displayed as the number of cases and percentage of prevalence. Categorical values were analyzed using the $\chi^2$ test and Fisher’s test. The Student’s t-test and Mann–Whitney U-test were used in analyzing quantitative values. Conducted was a univariational logistic regression analyses for the identify the association between clinical variables and perioperative outcomes (within 30 days after CEA). Statistically hypothesis was tested on a level of $\alpha = 0.05$, that is, the difference between samples was considered significant if p < 0.05. Statistical analysis was conducted with the help of IBM SPSS Statistics ver. 21.0.

Results

In our retrospective comparative study, a total of 273 CEA were performed, (171 (62.6%) males and 102 (37.4%) females underwent CEA). In the SCSO group were 40 CEA (14.7%) and in the non-SCSO group were 233 (85.3%). During the study, the staging procedure of bilateral CEA was performed on 24 patients: Nine CEA in the group which was non-SCSO and 15 CEA in the SCSO group. Of the patients in the SCSO group who underwent the staging procedure of bilateral CEA, the first CEA which was done on the primary (ipsilateral) lesion was included in the SCSO.
group, and the second CEA (contralateral lesion) after the first CEA was included in the non-SCSO group.

The average age of patients in the study was 66.17 years (standard deviation ± 8.1, in the range of 46–86 years), the average age of patients in the non-SCSO group was 66.06 years (standard deviation, ± 8.2) (p = 0.596), while the average age of patients in the SCSO group was 66.08 years (standard deviation, ± 7.1) (p = 0.689), the presence of males is larger in both groups (62.2% compared 65%) without statistical significance, p = 0.875. The presence of pre-operative risk factors and comorbidities, in the studied groups, was without statistical significance smoking 106 (45.5%) compared to 14 (35%), p = 0.288; HTN 202 (86.7%) compared to 35 (87.5%), p = 0.998; HLP 195 (83.7%) compared to 33 (82.5%), p = 0.964; DM 73 (31.3%) compared 19 (47.5%), p = 0.069; CAD 51 (21.9%) compared to 12 (30%), p = 0.357; and PAD 53 (22.7%) compared to 7 (17.5%), p = 0.594 (Table 1). Analyzing the statistics regarding the CEA procedure, no statistically significant differences between the examined groups in anesthesia technique which was used during the procedure (local anesthesia 74.2% compared, 72.5%, general anesthesia 25.8% compared 27.5%), p = 0.970. The SCSO group had a larger, more statistically significant number: Symptomatic patients (54.1% compared to 87.5%, p < 0.0005), CEA with patch angioplasty (25.3% compared to 52.5%, p = 0.001), and CEA with the use of a shunt (3.9% compared to 35%; p < 0.0005) (Table 1).

Perioperative outcomes are displayed in Table 2. For all patients, the rate of stroke of any cause within 30 days was 1.8%, ipsilateral 1.1%, while the rate of contralateral measured 0.7%. The rate of mortality within 30 days for all patients was 0.7%, and the combined rate of stroke/mortality was 2.5%. There was no statistically significant difference between the compared groups regarding any type of stroke (1.8% vs. 2.5%, p = 0.55), ipsilateral (0.9% vs. 2.5%, p = 0.379), mortality (0.4% vs. 2.5%, p = 0.272), and combined rate of mortality/stroke (2.2% vs. 5%; p = 0.273).

Logistically regression showed that SCSO is an independent predictor of 30-day mortality (OR 21.58; 95% CI 1.27–36.3; p = 0.033) and any type of stroke/mortality (OR 9.27; 95% CI 1.61–53.22; p = 0.012). SCSO was not a predictor of stroke of any type within 30 days. Predictors of stroke of any type were dyslipidemia (OR 0.12, 95% CI 0.02–0.76; p = 0.024) (Table 3).

### Discussion

Following the first CEA done by DeBakey [22], the procedure has been established as a safe and effective method in lowering the risk of CVI in patients with significant carotid stenosis. Today, CEA is a method with low mortality and perioperative complications, in symptomatic [23] and in unsymptomatic stenosis of the carotid arteries [24].

The results of our study indicate that SCSO is a predictor of 30-day mortality in combined stroke of any cause/death. These conclusions are in line with the findings of Kanga et al. [25]. The research by Goodney et al. showed that contralateral carotid occlusion was an independent predictor of any type of perioperative stroke/death (OR: 2.8; 95% CI: 1.3–6.2; p = 0.009) [26]. Similar results were published in other studies as well [27].

In contrast to the results of our study, certain research did not show a statistically significant difference in perioperative results following CEA in patients with contralateral carotid disease [18], [20]. SCSO was a predictor of stroke of any cause/death within 30 days, but it was not an independent predictor of ipsilateral or contralateral stroke. In terms of percentages, perioperative stroke in our study was found in a higher number on the contralateral side.

### Table 1: Clinical characteristics of the study's patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n = 273, n (%))</th>
<th>Non-SCSO (n = 233, n (%))</th>
<th>SCSO (n = 40, n (%))</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) ± SD</td>
<td>66.17 ± 8.1</td>
<td>66.06 ± 8.2</td>
<td>66.08 ± 7.1</td>
<td>0.689</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>171 (62.6)</td>
<td>145 (62.2)</td>
<td>26 (65)</td>
<td>0.875</td>
</tr>
<tr>
<td>Female</td>
<td>102 (37.4)</td>
<td>88 (37.8)</td>
<td>14 (35)</td>
<td></td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAD</td>
<td>63 (23.1)</td>
<td>51 (21.9)</td>
<td>12 (30)</td>
<td>0.357</td>
</tr>
<tr>
<td>PACD</td>
<td>60 (22)</td>
<td>53 (22.7)</td>
<td>7 (17.5)</td>
<td>0.594</td>
</tr>
<tr>
<td>Carotid stenosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCSO</td>
<td>40 (14.7)</td>
<td>NA</td>
<td>40 (100)</td>
<td>NA</td>
</tr>
<tr>
<td>Several stenosis</td>
<td>27 (9.9)</td>
<td>NA</td>
<td>27 (87.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>13 (4.8)</td>
<td>NA</td>
<td>13 (32.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Symptomatic status, CEA</td>
<td>161 (59)</td>
<td>126 (54.1)</td>
<td>35 (87.5)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>General anesthesia</td>
<td>71 (26)</td>
<td>60 (25.8)</td>
<td>11 (27.5)</td>
<td>0.970</td>
</tr>
<tr>
<td>Local anesthesia</td>
<td>202 (74)</td>
<td>173 (74.2)</td>
<td>29 (72.5)</td>
<td></td>
</tr>
<tr>
<td>Use of shunt</td>
<td>23 (8.4)</td>
<td>9 (3.9)</td>
<td>14 (35)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Reconstruction technique</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patch angioplasty</td>
<td>80 (29.3)</td>
<td>59 (25.3)</td>
<td>21 (52.5)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Eversion</td>
<td>193 (70.7)</td>
<td>174 (74.7)</td>
<td>19 (47.0)</td>
<td></td>
</tr>
<tr>
<td>Risk factor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>237 (86.4)</td>
<td>202 (86.7)</td>
<td>35 (87.5)</td>
<td>0.998</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>228 (83.5)</td>
<td>195 (83.7)</td>
<td>33 (82.5)</td>
<td>0.964</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>92 (33.7)</td>
<td>73 (31.3)</td>
<td>19 (47.5)</td>
<td>0.069</td>
</tr>
<tr>
<td>Smoking</td>
<td>120 (44)</td>
<td>106 (45.5)</td>
<td>14 (35)</td>
<td>0.286</td>
</tr>
</tbody>
</table>

*Values are presented as mean ± SD or n (%). SD: Standard deviation, CAD: Coronary artery disease, CEA: Carotid endarterectomy, NA: Not applicable; PACD: Peripheral arterial occlusive disease, SCSO: Severe contralateral carotid stenosis or occlusion.
Similar findings to those in our study were found in other studies [28]. The reason for such results in our research may be found in the fact that post-occlusive pressure following clamping of the carotid arteries in the SCSO group was significantly lower compared to the non-SCSO patient group, and in those cases, to protect the cerebral circulation, intraoperative use of a temporary shunt (3.9% vs. 35%; p < 0.0005), which resulted in a statistically larger number of CEA/PA patch plasty (25.3% vs. 52.5% p < 0.001). Similar to our findings, in other studies, we may also identify a larger rate of the usage of intraoperative shunts in patients with contralateral carotid disease [18], [29], [30].

Table 2: Perioperative outcomes of all patients undergoing carotid endarterectomy comparing those with versus those without severe contralateral carotid stenosis or occlusion

<table>
<thead>
<tr>
<th>Variable Within 30-day outcomes after CEA</th>
<th>Total (n=273), n (%)</th>
<th>Non-SCOS (n = 233), n (%)</th>
<th>SCSO (n = 40), n (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>2 (0.7)</td>
<td>2 (0.9)</td>
<td>0</td>
<td>0.984</td>
</tr>
<tr>
<td>Any stroke</td>
<td>5 (1.8)</td>
<td>4 (1.8)</td>
<td>1 (2.5)</td>
<td>0.550</td>
</tr>
<tr>
<td>Ipsilateral</td>
<td>2 (0.7)</td>
<td>2 (0.9)</td>
<td>0</td>
<td>0.984</td>
</tr>
<tr>
<td>Contralateral</td>
<td>3 (1.1)</td>
<td>0 (0.0)</td>
<td>3 (7.5)</td>
<td>0.379</td>
</tr>
<tr>
<td>Any stroke/death</td>
<td>7 (2.5)</td>
<td>5 (2.2)</td>
<td>2 (5)</td>
<td>0.273</td>
</tr>
</tbody>
</table>

SCSO: Severe contralateral carotid stenosis or occlusion.

In their research, Hans et al. reported the lower rate of shunt usage in patients in whom there is continued monitoring of neurologic status, meaning in patients in whom CEA was conducted under regional anesthesia [31]. This study shows that SCSO is a risk factor for early perioperative (0–30 day) death and stroke of any cause/death following CEA. Despite this, SCSO must not be a reason why CAS should be favored over CEA [32]. Other studies also dispute the plausibility that contralateral occlusion is used as an indication to favor CAS over CEA [33]. Regarding the larger number of post-operative neurologic complications following CAS compared to CEA in patients with contralateral carotid occlusion and occlusion of the vertebral arteries, Yang et al. [34] reported similar findings to the specific study, and other studies point out that contralateral occlusion may not be an indication to favor CAS over CEA [35].

The study by Demirel et al. illuminates the advantage belonging to C-CEA, by reporting the larger 30-day risk of CVI and death in patients treated with the E-CEA technique (9% compared to 3%, p = 0.005) [36], differing from other studies, which do not have similar findings to our study, and which show the significantly lower mortality and morbidity (1.35% compared to 4%, p < 0.005) [37] as well as the smaller number of CVI (0.9% compared to 2.9%, p < 0.01) and the rate of death 1.8%, compared to 0.54%, p < 0.05 [38], in patients operated on with the E-CEA technique.

Conclusions

Our results contribute to the ongoing debate about the effects of SCSO on early 30-day outcomes following CEA. We identified SCSO as a risk factor for mortality and stroke of any cause/mortality. The results of our research lower cerebral perfusion pressures exist in patients with SCSO which results in more significant preoperative symptoms and exemplifies the need for the usage of an intraoperative intraluminal shunt. SCSO is a predictor of early death following CEA. These patients have a significant burden of cardiovascular risk factors, and thus, aggressive control of these risk factors should be undertaken. Patients with SCSO in whom CEA is planned may benefit from attentive perioperative hemodynamic monitoring and as previously mentioned, usage of a selective intraoperative shunt.

References

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