Brief communication - Carotid and imaging
Postoperative internal carotid artery restenosis after local anesthesia: presence of risk factors versus intraoperative shunt

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Abstract

Published data suggest that the regional anesthetic technique used for carotid endarterectomy (CEA) increases the systolic arterial blood pressure and heart rate. At the same time local anesthesia reduced the shunt insertion rate. This study aimed to analyze risk factors and ischemic symptomatology in patients with postoperative internal carotid artery restenosis. The current retrospective study was undertaken to assess the results of CEA in 8000 patients who were operated during a five-year period in six regional cardiovascular centers. Carotid color coded flow imaging, medical history, clinical findings and atherosclerotic risk factors were analyzed. Among them, there were 33 patients (0.4%) with postoperative re-occlusion after CEA. The patients with restenosis were re-examined with carotid color coded flow imaging and data were compared with 33 consecutive patients with satisfactory postoperative findings to serve as a control group. In the restenosis group eight risk factors were analyzed (hypertension, smoking, hyperlipidemia, diabetes mellitus, history of stroke, transitory ischemic attack, heart attack and coronary disease), and compared with risk factors in control group. Study results suggested that early postoperative internal carotid artery restenosis was not caused by atherosclerosis risk factors but by intraoperative shunt usage.

Keywords: Carotid endarterectomy; Local anesthesia; Risk factors; Complications

1. Introduction

Indications for carotid endarterectomy (CEA) were well established from four level 1A clinical trials: the North American Symptomatic Carotid Endarterectomy Trial (NASCET) [1], the European Carotid Surgery Trial (ECST) [2], the Asymptomatic Carotid Atherosclerosis Study (ACAS) [3], and the Asymptomatic Carotid Surgery Trial (ACTS) [4].

Patients who undergo CEA in these study use resources as recommended by the AHA guidelines for CEA [5]. Currently, reliable data for defining an acceptable duration and intensity of postoperative monitoring are lacking [6]. Therefore, the Croatian Society for Neurovascular Disorders took an active part in the implementation of new concepts of stroke management and treatment to provide updated recommendations that can be used on adopting new treatment therapeutic methods and procedures. In this study, we strictly followed the mentioned rules which state that the first postoperative outpatient neurosonological control is recommended three months after CEA [7]. ICA restenosis usually develops early, within two years after surgery. If restenosis develops after a longer period of time, it is usually caused by well-established atherosclerosis risk factors that caused the original disease. The aim of this study was to analyze the risk factors, intraoperative usage of the shunt and ischemic symptomatology in patients with postoperative ICA restenosis.

2. Method

We retrospectively examined records of 8000 patients who underwent local anesthesia carotid endarterectomy (LA-CEA) in six regional cardiovascular departments during a five-year period. According to postoperative computed tomography angiography (CTA) and carotid color flow imaging (CCDFI) data, there were 33 (0.4%) patients with ICA restenosis in this group. There was a predominance of male patients (75.7%), and mean age was 68.7 (age range 50–85) years. A standard open LA-CEA was performed in all patients. A shunt was inserted if there was deterioration in the level of consciousness. Patch closure with a polytetrafluoroethylene (PTFE) patch material was undertaken in all study patients. Neurological events were classified as minor (transient ischemic attacks (TIA)) and major neurological deficits. Major neurological deficits were defined as those deficits that lasted beyond seven days. We confirmed intraoperative abnormal focal neurological signs by an electroencephalogram and/or prolonged electroencephalographic monitoring. All the patients with ICA restenosis were re-examined with CCDFI. Data on 33 consecutive patients with a satisfactory CTA and CCDFI postoperative findings were analyzed to serve as a control group.
follow-up CCFI examinations (restenosis/control group) were conducted by the same investigator using the same equipment (ALOKA 5500, 10-MHz linear probe).

$\chi^2$-test was used to examine differences between two groups of patients considering eight risk factors. Binary logistic regression analysis (dichotomous variable) was used to examine which risk factor is the most significant predictor for restenosis. All analyses were carried out using the SPSS 16.0.1 software package (SPSS Inc, Chicago, IL, USA).

### 3. Results

The patient demographic data are shown in Table 1. Significant postoperative ICA restenosis (25 patients/75%) 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 eight (24%) patients, four on either side. Contralateral ICA showed non-significant atherosclerotic changes in 27 (82%) patients, of which eight had undergone previous CEA. Twenty-four (72%) patients had moderate ICA restenosis and one (3%) patient had subtotal ICA restenosis. CCFI demonstrated ICA restenosis on the first follow-up examination taken three months after the CEA 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 (TIA in two patients and stroke in one patient). In the group with satisfactory postoperative finding, 17 patients had CEA on the right side, 12 on the left, and four patients had bilateral CEA. Contralaterally, 25 (76%) patients had non-significant atherosclerotic changes, six (18%) patients developed mild ICA restenosis, and two (6%) patients had occlusion of the contralateral ICA.

The presence of atherosclerotic risk factors (hypertension, smoking, hyperlipidemia, diabetes mellitus, history of TIA/stroke, history of myocardial infarction and coronary disease), and usage of intraoperative shunt were analyzed in both groups of patients. The results are presented in Table 2.

Statistically significant difference between two groups was found in the ‘operative shunt’ risk factor ($\chi^2 = 30.023, P = 0.00$).

Our results suggest that the significant predictors for restenosis are: operative shunt ($B = 7.653; P = 0.00$), smoking ($B = 2.826; P = 0.02$), previous stroke ($B = 3.023; P = 0.02$) and hyperlipidemia ($B = 3.531; P = 0.05$).

### 4. Discussion

Recognized risk factors for developing early postoperative ICA occlusion/restenosis were smoking, smaller diameter of ICA, defects found during surgery, and certain genotypes [8].

However, systemic risk factors, such as hypertension, hyperlipidemia, and obesity increase the risk of developing late postoperative ICA occlusion/restenosis (two years or more after CEA). Diabetes mellitus and age over 80 years have been established as risk factors for developing late postoperative ICA occlusion/restenosis as well as being a predictive factor for the increased risk of perioperative stroke or death (30 days after CEA) [8].

In our study atherosclerotic risk factors were present in a high percentage of the postoperative ICA occlusion/restenosis group but there was no significant difference from the control group.

According to the recent literature the incidence of brain ischemic symptoms in postoperative ICA restenosis varies between 1% and 4% [8, 9, 10]. In our series, three of 33 patients with postoperative ICA restenosis presented with ischemic symptoms (one stroke; two TIA), and moderate ICA restenosis of the contralateral ICA was found in six of 33 (18%) patients and contralateral ICA occlusion in two (6%) patients. To remove atheromatous plaque, surgeons must clamp the ICA. A shunt can be inserted to avoid brain

### Table 1. Patient characteristics according postoperative restenosis and control group

<table>
<thead>
<tr>
<th>Patients</th>
<th>Postoperative restenosis ($n = 33$)</th>
<th>Satisfactory postoperative finding ($n = 33$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>25 males/8 females</td>
<td>23 males/10 females</td>
</tr>
<tr>
<td>Age (years; mean ± S.D.)</td>
<td>68.7 ± 7.2</td>
<td>70.7 ± 7.2</td>
</tr>
<tr>
<td>Age at time of surgery (years)</td>
<td>65.6</td>
<td>65.8</td>
</tr>
<tr>
<td>Median postoperative follow-up (years)</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>Side of CEA</td>
<td>18 right/15 left</td>
<td>21 right/12 left</td>
</tr>
</tbody>
</table>

S.D., standard deviation; CEA, carotid endarterectomy.

### Table 2. Influence of eight risk factors for restenosis

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Patients</th>
<th>$\chi^2$-test</th>
<th>Binary logistic regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Postoperative restenosis</td>
<td>Satisfactory postoperative finding</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18</td>
<td>18</td>
<td>0.000</td>
</tr>
<tr>
<td>Smoking</td>
<td>11</td>
<td>10</td>
<td>0.070</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>13</td>
<td>8</td>
<td>1.746</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>7</td>
<td>9</td>
<td>0.330</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>7</td>
<td>13</td>
<td>2.583</td>
</tr>
<tr>
<td>Previous TIA</td>
<td>3</td>
<td>3</td>
<td>0.000</td>
</tr>
<tr>
<td>Previous IM</td>
<td>4</td>
<td>4</td>
<td>0.000</td>
</tr>
<tr>
<td>Operative shunt</td>
<td>25</td>
<td>3</td>
<td>30.023</td>
</tr>
</tbody>
</table>

$\chi^2$-test was used to examine differences between two groups of patients.

Binary logistic regression was used to examine which risk factors are significant predictors for restenosis.

P-value, statistical significance; B, estimate; df, degrees of freedom; TIA, transient ischemic attacks.
ischemia during clamping, but the shunt itself might dislodge a part of the plaque or damage the residual intima of the vessel, thus favoring postoperative restenosis. Our results suggest that postoperative ICA restenosis after LA-CEA is rare and mostly asymptomatic, and it is predominantly caused by intraoperative usage of a shunt (local shunt-microtrauma).

With road-mapping it is possible to superimpose live fluoroscopy on a radiographic image. A refurbished operating room with a fluoroscopy unit for intraoperative angiographic control will be of benefit to both patients and the operating team. Unfortunately, superior imaging, decreasing radiation and optimal ergonomics are still a barrier for vascular institutions in which this study was performed. Obviously, the realization of such an operating suite is essential for improving the every-day work in vascular centers.

References


