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Our Experience with the Use of Regional Anesthesia in the Treatment of Multiple Atherosclerotic Lesions of the Carotid Arteries in Patients with Coronary Heart Disease

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Abstract **Introduction:** Anesthesia for carotid endarterectomy (CEA), general or regional, has been an issue of debate in literature. The aim of this study was to evaluate the influence of regional anesthesia on perioperative mortality and morbidity in patients with ischemic heart disease undergoing carotid surgery. **Material and methods:** This prospective study included 117 consecutive patients with co-excisting multiple atherosclerosis of carotid and coronary arteries operated under cervical plexus block. **Results:** Shunt placement rate was 3.3%, and all patients had a good outcome. The average carotid clamping time was 19 minutes. Pulmonary complications were not observed. There was 1 death (0.9%) due to myocardial infarction. Two patients (1.7%), both symptomatic, had a small ipsilateral ischemic stroke with good recovery. **Conclusion:** Carotid artery endarterectomy can be safely performed in the awake patient, with low morbidity and mortality rates.

Keywords Anesthesia, Carotid surgery, Ischemic heart disease, Perioperative mortality, Coronary arteries, Cervical plexus block, Concomitant pathology, Atherosclerosis

1. Introduction

One of the options for the surgical treatment of patients with atherosclerosis, in particular with a combined lesion of the carotid and coronary arteries, is the reconstruction of both vascular regions – simultaneous or staged carotid endarterectomy (CEA) and coronary artery bypass surgery. The choice of such a surgical strategy is due to the fact that combined lesion of the carotid and coronary arteries often leads to the occurrence of such complications as myocardial infarction (MI) after CEA and stroke after cardiac surgery [1-3]. As a result, the anesthesiologist faces the difficult task of ensuring the safety of the patient with impaired cerebral and cardiac circulation, and it is the anesthetic management that becomes the factor determining the outcome of the operation [4,5].

Perhaps no other surgical intervention in modern anesthesiology is not associated with such a diametral divergence of opinions about the optimal method of anesthesia, as CEA. The main subject of discussion is the possibility of alternative use of either general or regional anesthesia.

Objective: to study the results of carotid endarterectomy under regional anesthesia in patients with a multiple atherosclerotic lesion of carotid and coronary arteries.

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2. Material and Methods

From August 2020 to December 2021, 122 consecutive carotid endarterectomies were performed on 117 patients with co-excisting atherosclerosis of carotid and coronary arteries under loco-regional anesthesia at the Republic Specialized Center of Surgical Angioneurology and Department of Vascular Surgery, Tashkent Medical Academy, Uzbekistan. All patients were included in a prospective registry, and signed a written informed consent form before surgery. This study was approved by the Research Ethics Committee of the Tashkent Medical Academy.

Patients were between 41 and 93 years old, the average age of patients was 59±7.8 years. There were 90 male (73.8%) and 32 (26.2%) female patients. All patients had various comorbidies, such as diabetes, hypertension, peripheral artery disease, dyslipidemia, chronic obstructive pulmonary disease (COPD) and chronic renal failure, which

are listed in Table 1.

Table 1. Concomitant pathology

Comorbidities	n (%)
Peripheral artery disease	15 (12.8 %)
Diabetes	32 (27.4 %)
Liver cirrhosis	3 (2.7 %)
Chronic obstructive pulmonary disease	22 (18.8 %)
Arterial hypertension	115 (98.3 %)
Dyslipidemia	42 (35.9 %)
Chronic renal failure	10 (8.6 %)

The carotid arteries of all patients were assessed by ultrasound duplex scanning (USDS) of the carotid arteries along with digital subtraction angiography or multislice computer tomographic angiography (MSCTA). The arteriography and MSCTA were performed to confirm the presence of hemodynamically significant stenosis (seen on USDS) and to calculate the degree of stenosis. For this calculation, we used the method described in the NASCET study [6]. CEA was indicated when the degree of stenosis in the internal carotid artery was greater than or equal to 70%.

The surgery was indicated for symptomatic stenosis in 99 arteries (81.1%), and asymptomatic stenosis in 23 arteries (18.9%). For the distribution of patients, depending on the degree of chronic cerebrovascular insufficiency, the classification by A.V.Pokrovskiy (1978) was used (Table 2) [7].

Table 2. Indications for carotid endarterectomy (122 procedures)

Degree of chronic cerebrovascular insufficiency	n (%)
I degree	23 (18.9 %)
II degree	7 (5.7 %)
III degree	43 (35.3 %)
IV degree	49 (40.1 %)

In addition to standard clinical studies, all patients underwent electrocardiography (ECG), echocardiography and selective coronary angiography. For the distribution of patients with angina pectoris, depending on the functional class (FC) of angina, the Canadian Cardiovascular Society (1976) classification was used (Table 3) [8].

Table 3. The distribution of patients depending on functional class of angina pectoris

Functional class of angina pectoris	n (%)
I	19 (16.2 %)
II	43 (36.8 %)
III	50 (42.7 %)
IV	5 (4.3%)

All patients received perioperative acetylsalicylic acid (100 mg/day), clopidogrel (75 mg/day) and statins (atorvastatin 20 mg/day or rosuvastatin 10 mg/day).

The technique used by our anesthesiology service was superficial and deep cervical plexus block, seeking to provide conditions for neurological assessment of the patient during the procedure in the operating room since, in our view, consciousness is the best parameter to know whether the patient's brain is suffering or not from ischemia. During pre-anesthetic assessment, we confirmed the possibility of performing the procedure and the patient was oriented regarding the loco-regional anesthesia. The patients were on continuous oxygen mask and were monitored with ECG, invasive blood pressure and strict control of heart rate; their brain function was monitored by the level of consciousness and motor activity in the upper and lower limb in the contralateral side of the body.

The superficial cervical plexus block was performed with subcutaneous injection of 5 to 10 ml of 0.5% bupivicaine solution along the posterior border of the sternocleidomastoid muscle. The deep cervical plexus block was performed with injection of the same anesthetic solution in the transverse processes of C2, C3, and C4 respectively, in a straight line drawn between the mastoid process and the C6 transverse process (Chassaignac's tuber). The needle was inserted perpendicular to the skin up to the transverse process and, after aspiration, 5 ml of solution was injected in each transverse process. The patient was maintained without sedation for improved neurological monitoring, and we used short-term opioids, such as alfentanil at a dose of 5 mg/kg if the patient had postural or emotional discomfort.

The operating table was adjusted so that the patient stayed in a semi-upright position (at an angle of 45°). Five minutes before placing the arterial clamps to do the carotid occlusion test (during 3 minutes), 5000 international units of unfractionated heparin were administered intravenously. Intraoperative cerebral monitoring consisted of neurological examination and observation for signs or symptoms of cerebral ischemia, such as changes in level of consciousness, seizures, slurred speech or motor deficit in the upper and lower limbs on the contralateral side of the body. The carotid shunt was used when the patient under loco-regional anesthesia and undergoing cerebral monitoring showed symptoms of cerebral ischemia.

3. Results

The carotid endarterectomies were performed with loco-regional anesthesia in 117 patients undergoing 122 surgeries: no patient required conversion to general anesthesia. Types of operation are listed in Table 4.

Table 4. Types of carotid artery reconstruction

Type of operation	n (%)
Carotid endarterectomy with autovenous patching	79 (64.8 %)
Eversion carotid endarterectomy	36 (29.5 %)
Resection and ligation of the internal carotid artery, endarterectomy from common and external carotid artery with autovenous patching	7 (5.7%)

It was necessary to use intraoperative shunt in 4 cases (3.3%). The first patient had stenosis of approximately 85% in the carotid being operated, and contralateral carotid occlusion; its circle of Willis was complete, and he had mental confusion followed by contralateral motor deficit in the arm and leg during the crossclamping test of the carotid artery. The second patient had 90% stenosis in the carotid being operated and stenosis of approximately 10% in the contralateral carotid artery, with a complete circle of Willis, and presented motor deficit in the contralateral upper limb during removal of the atherosclerotic plaque. The third patient had stenosis of approximately 70% in the carotid being operated, and 30% in the contralateral carotid artery, and its circle of Willis showed absence of the anterior cerebral artery; this patient showed mental confusion and motor deficit in the contralateral arm and leg during the crossclamping test. The fourth patient 80% in the carotid being operated, and 60% in the contralateral carotid artery, with a complete circle of Willis; this patient showed mental confusion during the crossclamping test. In those 4 cases, the neurological symptoms disappeared immediately after insertion of the shunt and the patients had a normal outcome.

The average crossclamping time of the internal carotid artery was 19 minutes, ranging between 13 and 31 minutes.

Perioperative mortality was 0.9%: one patient died of an acute myocardial infarction on the 3d day after the procedure. Two patients (1.7%), both symptomatic, had a small ipsilateral ischemic cerebral infarct with good recovery. In one case (0.09%) there was excessive bleeding through the drain, and the incision was reopened for revision of hemostasis. Considering that 22 (18.8%) patients were diagnosed with COPD, the refusal of intubation during anesthesia allowed us to avoid such frequent complications of the early postoperative period as hospital pneumonia and prolonged mechanical ventilation.

The average follow-up time was 32 months (6-192 months). USDS followup was performed in all patients. During the late postoperative period, there were no cases of ischemic stroke.

4. Discussion

Atherosclerosis is the disease of the century, both past and present. Atherosclerotic lesions of the carotid and coronary arteries are the leading cause of such a common catastrophe as stroke and myocardial infarction. Even for the USA with advanced medicine, where national programs for the prevention of atherosclerosis are implemented, the incidence of ischemic stroke is 1 per 100 population in terms of all age groups, and the ratio for the age group over 70 years is 10 times higher [1].

No other surgical intervention in modern anesthesiology is associated with such a diametral divergence of opinions about the optimal method of anesthesia, as CEA. The main subject of discussion is the possibility of alternative use of either general or regional anesthesia. The discussion about the optimal method of anesthesia continues today, and the arguments from both sides look quite convincing [9-11].

So as positive points of general anesthesia, her supporters indicate the following [12-14]:

a) reliable control of the airway;
b) the ability to control and manipulate the level of CO_2 in the blood;
c) the possibility of immediate pharmacological protection of the brain using barbiturates;
d) overall comfort of the operation for the patient (and for the surgeon), regardless of the duration of the procedure.

The disadvantages of the general anesthesia method are also well known and obvious [13,14]. These include:

a) the difficulty of early diagnosis of cerebral ischemia at the stage of crossclamping, as well as some complications of the early postoperative period (early postoperative thrombosis, hyperperfusion syndrome);
b) stress associated with tracheal intubation and extubation;
c) significantly higher frequency of cardiovascular disorders in the perioperative period, such as acute myocardial infarction, arterial hypertension, severe cardiac rhythm disturbances, compared with regional anesthesia.

Supporters of regional anesthesia bring its following benefits [15,16]:

a) the highest level of neuro-monitoring in terms of informativeness and ease of implementation is dynamic neurological monitoring, which allows immediate diagnosis of developing cerebral ischemia at the stage of crossclamping and in early postoperative period. This also eliminates the use of expensive and time-consuming modalities of neuro-monitoring, thereby saving time and money.
b) significantly lower frequency of using temporary inraarterial shunt.
c) lower incidence of severe cardiovascular disorders in the perioperative period compared with general anesthesia.
d) avoiding intubation and extubation of the trachea with their inherent stress.
e) shorter stay of the patient, both in the intensive care unit and in the clinic as a whole.

The disadvantages of regional anesthesia include the following points [17,18]:

a) emotional discomfort experienced by the operated patients present at their operation.
b) risk of so-called "mosaic blockade" or simply insufficient analgesia (significantly reduced when using a neurostimulator).
c) possibility of respiratory depression, including due to the blockade of the phrenic nerve on the side of anesthesia.

In addition, it should be remembered that regional

anesthesia by itself does not have a cardio-protective effect on myocardial ischemia, but only reduces the number of stressful situations (for example, intubation and extubation of the trachea) [19].

The GALA (General Anesthesia vs Local Anesthesia) study is the largest randomized surgical and anesthesiological study, involving 3,526 patients treated in 95 centers in 24 countries. This bidirectional, in parallel groups, a multicenter randomized controlled trial was organized to determine whether the type of anesthesia affects perioperative overall mortality and mortality from stroke, the quality of life in the short term, and the absence of strokes and heart attacks during one year of observation. Analysis of the results has shown that neurological complications on the contralateral side in case of occlusion of the contralateral artery were more likely in the general anesthesia group (54% vs 29%). Thus, local anesthesia had an advantage in patients with contralateral occlusion. Observation during the year in the GALA study showed a slightly lower incidence of end-point detection in patients operated on under local anesthesia ($p < 0.094$) [20].

It should be noted that the incidence of complications for groups with both general and local anesthesia was significantly lower than in NASCET and ECST studies, and this is evidence of a significant improvement in CEA results in recent years [20].

Despite a significant amount of researches, published in the literature, which analyzes the advantages and disadvantages of both approaches, including comparative studies, the conclusion about the advantages of one of the methods has not yet been made.

5. Conclusions

The high risk of general anesthesia associated with concomitant and underlying diseases such as severe forms of coronary heart disease, chronic lung disease raises the necessary question of performing carotid endarterectomy under regional anesthesia in this category of patients. The use of regional anesthesia in carotid surgery in patients with multiple atherosclerotic lesion of the carotid and coronary arteries leads to a significant decrease in anesthetic risk, cerebral, pulmonary and cardiac complications.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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