Cervical plexus block versus general anesthesia in carotid surgery: single center experience

Dejan Markovic[1], Gordana Vlajkovic[1], Radomir Sindjelic[1], Dragan Markovic[2], Nebojsa Ladjevic[1], Nevena Kalezic[1]

[1]Center for Anesthesia, Clinical Center of Serbia, Faculty of Medicine, University of Belgrade, Serbia
[2]Clinic for Vascular and Endovascular Surgery, Clinical Center of Serbia, Faculty of Medicine, University of Belgrade, Serbia

Submitted: 20 September 2011
Accepted: 3 January 2012

Arch Med Sci 2012; 8, 6: 1035-1040
DOI: 10.5114/aoms.2012.32411

Corresponding author:
Dejan Markovic MD, PhD
Center for Anesthesia
Clinical Center of Serbia
Faculty of Medicine
University of Belgrade
Koste Todorovica 8
11000 Belgrade, Serbia
Phone: +381668300903
E-mail:
dmdemark7@gmail.com

Abstract

Introduction: Carotid endarterectomy may be performed under general (GA) or regional anesthesia (RA). The aim of this study was to evaluate the influence of anesthetic techniques on perioperative mortality and morbidity in patients undergoing carotid surgery.
Material and methods: This prospective study included 1098 consecutive patients operated on between 2003 and 2009 (773 underwent cervical plexus block and 325 underwent general anesthesia).
Results: There were 6 deaths, 3 (0.9%) after GA and 3 (0.4%) after RA ($p = 0.272$). Neurological complication rates were not significantly different (GA 2.1% vs. RA 1.1%, $p = 0.212$). Incidence of myocardial infarction was similar (GA 0.31% vs. LA 0.39%, $p = 0.840$). Shunt placement rate was the same in both groups, 11.1%. Total operating time and carotid clamping time were significantly shorter in RA patients (RA: 92 min vs. GA: 106 min; $p < 0.001$ and RA: 18 min vs. GA: 19 min; $p = 0.040$). There was no significant difference in number of reinterventions (RA: 1.0% vs. GA: 0.6%; $p = 0.504$). Pulmonary complications were common in the GA group (RA: 0 vs. GA 0.9%; $p = 0.007$). Time to first postoperative analgesic was significantly shorter in the GA group (RA: 226 min vs. GA: 139 min; $p < 0.001$).
Conclusions: Type of anesthesia does not affect the outcome of surgical treatment of carotid disease. However, it should be stressed that fewer respiratory complications, later requirement for first postoperative analgesic, and an awake patient who can continue oral therapy early after surgery, give priority to regional techniques of anesthesia.

Key words: carotid endarterectomy, cervical plexus block, general anesthesia.

Introduction

Carotid artery disease presents a local manifestation of systemic disease. Carotid endarterectomy is a preventive intervention that reduces the risk of fatal or disability stroke in patients with symptomatic or asymptomatic hemodynamically significant carotid stenosis [1-3]. Although only a preventive procedure, it carries the risk of perioperative complications, neurological and cardiac, primarily due to the high incidence of associated coronary artery disease and diabetes mellitus. This operation can be performed under general (GA) or regional anesthesia (RA). Results of nonrandomized trials favor regional techniques of anesthesia over general anesthesia [4-10], whereas results of the largest randomized trial GALA and other smaller randomized trials showed that there are no significant differences in outcome between patients under regional or general anesthesia in carotid surgery [11-17].

The aim of this study was to evaluate the influence of anesthetic techniques (regional and general anesthesia) on perioperative mortality and morbidity in patients undergoing carotid surgery.

Material and methods

After obtaining institutional review board approval and written informed consent, all 1098 consecutive adult carotid patients operated on between 2003 and 2009 at a single center were enrolled in this non-randomized study. The data were collected prospectively from 2006 to 2009 and retrospectively from 2003 to 2006. Seven thousand and seventy-three patients were operated on under regional anesthesia (RA group) while 325 patients were operated on under general anesthesia (GA group). Indications for surgery were based on recommendations of randomized controlled trials. Exclusion criteria included a simultaneous carotid endarterectomy with another operative procedure such as coronary artery bypass or valve surgery. Preoperatively all patients underwent evaluation with duplex ultrasound; thus carotid angiography was performed in some cases. All patients were premedicated with midazolam 0.05 mg/kg intramuscularly 30 min before the operation. In both groups intraoperative monitoring included electrocardiography, invasive blood pressure measured from the contralateral radial artery and pulse oximetry. The choice of anesthesia was dictated by preference of the attending anesthesiologist and surgical staff. Induction in general anesthesia was performed with propofol, fentanyl and rocuronium, and maintenance of anesthesia was conducted with isoflurane, fentanyl and rocuronium. Monitoring of neurological function during general anesthesia was based on stump pressure, and selective shunting used if stump pressure was below 50 mm Hg. In the regional anesthesia group, combined deep and superficial cervical plexus block was performed with the patients in supine position with head away from the side of surgery using a mixture of local anesthetics: 20 ml 0.5% bupivacaine and 12 ml 2% lidocaine. Deep cervical plexus block was performed by injecting 3-5 ml of local anesthetics at each of the transverse processes C2, C3, C4, while superficial cervical plexus block was performed with infiltration of 15 ml of local anesthetics mixture along the posterior border of the sternocleidomastoid muscle. Supplemental local anesthesia was administered by the surgeon using 2-3 ml of 1% Xylocaine into the carotid sheath. Neurological monitoring was carried out by verbal communication with the patient and contralateral hand grip testing during 4 min after internal carotid artery clamping. Any deterioration either in level of consciousness or hand grip was an indication for protective intraluminal shunt placement. In both groups, 100 international units of heparin were administered before carotid artery clamping and neutralized at the end of surgery with an appropriate amount of protamine. After surgery, the patients were observed for the next 24 h at the intensive care unit and were given tramadol 50 mg *i.m.* or diclofenac 75 mg *i.m.* to relieve pain that scored > 3 on a visual rating scale. Patients were observed at the vascular surgery department until discharge from hospital (next 2-3 days).

The primary aim of this study is to investigate the difference in the incidence of neurologic morbidity and mortality between patients operated on under cervical plexus block and those operated on under general anesthesia. A secondary goal is to investigate the difference in the incidence of other adverse events in these groups, such as cardiac or pulmonary morbidity and mortality, anesthesia and surgical complications as well as time for the first analgesic requirement.

Statistical analysis

The statistical difference between groups was tested with methods of parametric statistics (*T* test and Mann-Whitney U test) and non-parametric statistics (χ^2 test and Fisher's exact test). A p value less than 0.05 was considered statistically significant. According to a power analysis, a sample size of 1098 patients had a power of 70.6%, at a significance level of 0.05 using the χ^2 test to detect a reduction in total perioperative complications using regional techniques of anesthesia. As the outcomes in the primary aim are small, better power of the study is obtained if we use one of the secondary aims (time to first postoperative analgesic); we achieve 99% power to detect a significant difference in this outcome between the two observed groups, at a two-tailed significance level of 0.05, using the *t*-test.

Results

Patient characteristics are shown in Table I. There were no significant differences with regard to age (mean age was RA 65.8 ±8 years vs. GA 65.3 ±8 years; p = 0.308) or sex between RA and GA groups (RA: male 63.9%, female 36.1% vs. GA: male 65.8%, and female 34.2%; p = 0.540). In our study we found there were no significant differences in preoperative ASA status between the two groups (RA group: ASA I 4.3%, ASA II 47.9%, ASA III 47.9% vs. GA group: ASA I 4.6%, ASA II 47.1%, ASA III 48.3%; p > 0.05). We found no significant differences in the number of patients with preoperative hypertension (RA: 89.5% vs. GA: 88.6%; p = 0.658), coronary artery disease (RA: 36.9% vs. GA: 41.5%; p = 0.158), pulmonary disease (RA: 7.5% vs. GA: 9.2%; p = 0.336) and diabetes (RA: 31.7% vs. GA: 29.2%; p = 0.065). The number of patients with symptomatic carotid lesions was similar in both groups (RA: 58% vs. GA: 63%; p = 0.102), while preoperative renal disease was common in the RA group (RA: 4.3% vs. GA: 1.8%; p = 0.048).

Table I. Preoperative patient characteristics

Parameter	General anesthesia (GA)	Regional anesthesia (RA)	Value of *p*
Age	65.3 ±8	65.8 ±8	0.308
Sex:			
M	214 (65.8%)	494 (63.9%)	0.540
F	111 (34.2%)	279 (36.1%)	0.540
Preoperative ASA status:			
I	15 (4.6%)	33 (4.3%)	0.790
II	153 (47.1%)	370 (47.9%)	0.811
III	157 (48.3%)	370 (47.9%)	0.893
Preoperative symptomatic lesion	206 (63%)	449 (58%)	0.102
CAD	135 (41.5%)	286 (36.9%)	0.158
Hypertension	288 (88.6%)	692 (89.5%)	0.658
Diabetes mellitus	95 (29.2%)	245 (31.7%)	0.065
COPD	30 (9.2%)	58 (7.5%)	0.336
CRF	6 (1.8%)	33 (4.3%)	0.048

CAD – coronary artery disease, COPD – chronic obstructive pulmonary disease, CRF – chronic renal failure

Table II. Operative and postoperative variables

Variable	General anesthesia (GA)	Regional anesthesia (RA)	Value of *p*
Surgery:			
EA	280 (86.2%)	660 (85.4%)	0.739
Other	45 (13.8%)	113 (14.6%)	0.739
Total operating time [min]	106 ±35	92 ±22	< 0.001
Carotid clamping time [min]	19 ±8	18 ±8	0.040
Shunt use	36 (11.1%)	86 (11.1%)	0.981
Cerebral complication:			
Total	7 (2.1%)	9 (1.1%)	0.212
CVI	1 (0.3%)	3 (0.4%)	0.840
TIA	6 (1.8%)	6 (0.8%)	0.120
Myocardial infarction	1 (0.3%)	3 (0.4%)	0.840
Pneumonia	3 (0.9%)	0	0.007
Death	3 (0.9%)	3 (0.4%)	0.272
Length of hospital stay [days]	7	6	0.149
Reintervention:			
Total	2 (0.6%)	8 (1%)	0.504
Hemorrhagia	1 (0.3%)	4 (0.5%)	0.637
Thrombosis	1 (0.3%)	4 (0.5%)	0.637
Time to first postoperative analgesic [min]	139 ±173	226 ±260	< 0.001

EA – endarterectomy, CVI – cerebrovascular insult, TIA – transient ischemic attack

Table III. Intraoperative blood pressure changes

Variable	RA	GA	Value of *p*
Hypotension	97 (12.5%)	124 (38.1%)	< 0.001
Hypertension	328 (42.4%)	88 (27.1%)	< 0.001
Hypotension and hypertension	183 (23.7%)	70 (21.5%)	0.443
Unchanged	165 (21.3%)	43 (13.2%)	0.002

Table IV. Postoperative blood pressure changes in ICU

Variable	RA	GA	Value of *p*
Hypotension	5 (0.6%)	21 (6.5%)	< 0.001
Hypertension	254 (32.8%)	257 (79.1%)	< 0.01
Hypotension and hypertension	13 (1.7%)	28 (8.6%)	< 0.01
Unchanged	501 (64.8%)	19 (5.8%)	< 0.01

Operative variables in the groups are shown in Table II. There was no significant difference in surgical technique between groups (eversion carotid endarterectomy RA: 86% vs. GA: 85%; $p = 0.739$). Total operating time and carotid clamping time were shorter in patients under RA (RA: 92 min vs. GA: 106 min; $p < 0.01$, and RA: 18 min vs. GA: 19 min; $p = 0.040$). We found no statistically significant differences in shunt use (RA: 11% vs. GA: 11%; $p = 0.981$), cerebral complications (total RA: 1.1% vs. GA: 2.1%; $p = 0.212$ – stroke RA: 0.4% vs. GA: 0.3%; $p = 0.840$ and TIA, RA: 0.8% vs. GA: 1.8%; $p = 0.120$) or cardiac complications (RA: 0.4% vs. GA: 0.3%; $p = 0.840$). There were no statistically significant differences in perioperative mortality (RA: 0.4% vs. GA: 0.9%; $p = 0.272$), length of hospital stay (RA: 6 days vs. GA: 7 days; $p = 0.149$) or number of reinterventions (RA: 1.03% vs. GA: 0.61%; $p = 0.504$). Postoperative pulmonary complications were common in the GA group (RA: 0 vs. GA 0.9%; $p = 0.007$) and time to first postoperative analgesic requirement was significantly shorter in the GA group (RA: 226 min vs. GA: 139 min; $p < 0.001$).

The conversion rate from regional to general anesthesia was 2.1% (in 11 patients analgesia was unsatisfactory, 1 patient had neurotoxic side effects of local anesthetics, and in 4 patients neurologic deterioration with agitation occurred after carotid clamping).

Intraoperative and postoperative hemodynamic parameters are shown in Tables III and IV. Patients who underwent the operation with GA had significantly greater intraoperative (GA: 87% vs. RA: 79%; $p = 0.002$) and postoperative hemodynamic variability (GA: 94% vs. RA: 35%; $p < 0.01$).

Discussion

Carotid endarterectomy is preventative surgery but carries a risk of primarily cardiac and neurological perioperative complications. The patient benefits from this operation only if the incidence of perioperative complications is low, which could influence choice of anesthetic technique. The use of regional anesthesia in aortic surgery improves the outcome of surgical treatment [18, 19]. Conduction of afferent impulses from the surgical site to the central nervous system has been blocked with use of regional anesthesia and the stress response to surgical trauma is reduced (reducing the level of circulating stress hormones). It also avoids the occurrence of hypercoagulability state, improves the graft flow and reduces graft thrombosis [20], as well as avoiding mechanical ventilation, intubation and extubation, and all potential complications related to mechanical ventilation. Additionally, in carotid surgery regional anesthesia techniques provide exact neurological monitoring and give the most precise indication for intraluminal protective shunt placement. Results of nonrandomized trials suggest better hemodynamic stability and fewer cardiovascular and neurological complications with use of regional anesthesia techniques [4-10], while results of randomized trials show no significant differences in perioperative morbidity and mortality between patients operated on under general or regional anesthesia [11-17]. Surprisingly, the level of stress hormones during carotid surgery is higher in patients under regional anesthesia than in patients under general anesthesia [21]. Guay in a meta-analysis of 48 trials (34 retrospective and 14 prospective trials which compare regional and general anesthesia in carotid surgery) showed that the number of patients in prospective randomized trials is insufficient to reach a valid conclusion. A sufficient number of patients is obtained when the number of patients in prospective studies is added to patients of retrospective studies, and then better outcome is associated with the use of regional anesthesia techniques [22]. Later, Rothwell and Rerkasem in a meta-analysis of 9 smaller randomized trials together with the results of the largest randomized trial, GALA, found that there are no statistically significant differences in perioperative neurologic and cardiac morbidity and mortality between the two techniques of anesthesia [23]. Thus regional anesthesia has no advantages compared to general anesthesia in carotid surgery, and vice versa.

In keeping with the recently published data from the GALA trial, results of our study on 1098 consecutive patients showed that there were no significant differences in mortality and perioperative cardiac and neurological complications between patients operated on under general or under regional anesthesia. In our series incidence of mortality and neurological complications was nonsignificantly higher in the GA group than in the RA group, while incidence of myocardial infarction was insignificantly higher in the RA group than in the GA group. It is well known that the major complications of carotid endarterectomy may be due to hemodynamic factors. Cardiovascular lability in carotid patients undergoing anesthesia and surgery is a well-documented problem. Our results showed that patients who underwent the operation with GA had significantly greater intraoperative and postoperative hemodynamic variability and received more vasoactive medications during surgery and in the intensive care unit. During surgery patients under regional anesthesia had more hypertensive episodes, while patients under general anesthesia had more hypotensive episodes treated with vasoactive drugs. After surgery, patients in the RA group were more hemodynamically stable and 65% of them did not need blood pressure manipulation during the first 24 postoperative hours, while patients in the GA group (94%) had significantly greater hemodynamic variability and need for vasoactive medications. Interestingly, incidence of shunt placement was the same in both groups: 11.1%. Although it has been shown that stump pressure alone is not a reliable indicator of hemodynamic changes that predict cerebral ischemia, stump pressure measurement was the most commonly used parameter to dictate shunt deployment in the GALA study [11, 24]. Results of two recent studies showed that stump pressure may be a reliable predictor of adequate cerebral perfusion during carotid endarterectomy performed under general anesthesia [25, 26]. Our results support these findings.

There were no significant differences in the number of reinterventions due to thrombosis or hematoma (there were slightly more reinterventions in the RA group: 1% vs. 0.6% in the GA group). Our results showed significant differences in the total duration of surgery and duration of carotid artery clamping (statistically significantly shorter in patients in the RA group). This is more a consequence of surgeons' consciousness that the patient is awake, resulting in faster work, than the consequence of anesthesia choice (cervical plexus block administration lasts longer than induction in general anesthesia). There was a significant difference in the number of postoperative pulmonary complications (3 patients in the general anesthesia group had postoperative pneumonia, while patients in the regional anesthesia group were without pulmonary complications). In our study time to the first request for postoperative analgesics was significantly shorter in patients under general anesthesia.

The number of conversions from regional to general anesthesia was 16 (2.1%). This result is similar to the incidence of conversion in the GALA trial (1.4%). The largest number of conversions was due to unsatisfactory analgesia (11; 1.4%), in 4 cases (0.5%) due to psychomotor agitation after carotid artery clamping and in 1 case (0.1%) due to neurotoxic side effects of local anesthetics.

Our study has some limitations. The main limitations include the fact that it is nonrandomized, some patients were observed retrospectively, and the power of the study is 70.6% for the primary aim. A large prospective randomized study for consecutive patients would be necessary to confirm the conclusions of our study.

In conclusion, type of anesthesia does not affect the outcome of surgical treatment of carotid disease. However, it should be stressed that fewer respiratory complications, later requirement for first postoperative analgesic, and an awake patient who can continue oral therapy early after surgery give priority to regional techniques of anesthesia.

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