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

Dejan Markovic¹, Gordana Vlajkovic¹, Radomir Sindjelic¹, Dragan Markovic¹, Nebojsa Ladjevic¹, Nevena Kalezic¹

A b s t r a c t

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.

This prospective study included 1098 consecutive patients operated on between 2003 and 2009 (773 underwent cervical plexus block and 325 underwent general anesthesia).

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).

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 anes-
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 ($\chi^2$ 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 $\chi^2$ 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
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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
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: 11% 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%; \( p < 0.01 \)).

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%) | 98 (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          |

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 affrent 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 region
monar y 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.

References

1. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. N Engl J Med 1991; 325: 445-53.
2. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. Endarterectomy for asymptomatic carotid artery stenosis. JAMA 1995; 273: 1421-8.
3. Corrigan J, Greiner A, Erickson SE. Fostering rapid advances in health care: learning from system demonstrations. Institute of Medicine of the National Academies Press, Washington 2002.
4. Fiorani P. General anaesthesia versus cervical block and perioperative complications in carotid artery surgery. Eur J Vasc Endovasc Surg 1997; 13: 37-42.
5. McCleary AJ, Maritati G, Gough MJ. Carotid endarterectomy: local or general anaesthesia? Eur J Vasc Endovasc Surg 2001; 22: 1-12.
6. Sbarigia E, Speziale F, Colonna M, et al. The selection for shunting in patients with severe bilateral carotid lesions. Eur J Vasc Surg 1993; 7 (suppl A): 3-7.
7. Tangkanakul C, Counsell C, Warlow CP. Local versus general anaesthesia in carotid surgery: a prospective randomized study. Eur J Vasc Endovasc Surg 1989; 3: 503-9.
8. Lutz M, Michael R, Gahi B, Savolainen H. Local versus general anaesthesia for carotid endarterectomy-improving the gold standard? Eur J Vasc Endovasc Surg 2008; 36: 145-9.
9. Gabelman C, Gann D, Ashworth C, Carney Jr W. One hundred consecutive carotid reconstructions: local versus general anaesthesia. Am J Surg 1983; 145: 477-82.
10. Gürier O, Yapıcı F, Enq Y, Qinhar B, Ketenci B, Özler A. Local versus general anaesthesia for carotid endarterectomy: report of 329 cases. Vasc Endovascular Surg 2003; 37: 171-7.
11. GALA Trial Collaborative Group. General anaesthesia versus local anaesthesia for carotid surgery (GALA): a multicentre randomized controlled trial. Lancet 2008; 372: 2132-42.
12. Sbarigia E, DarioVizza A, Antonini M, et al. Locoregional versus general anaesthesia in carotid surgery: is there an
impact on perioperative myocardial ischemia? Results of a prospective randomized trial. J Vasc Surg 1999; 30: 131-8.

13. Forssell C, Takolander R, Bergqvist D, et al. Local versus general anaesthesia in carotid surgery. A prospective, randomised study. Eur J Vasc Surg 1999; 3: 503-9.

14. Godin MS, Bell WH 3rd, Schwedler M, et al. Cost effectiveness of regional anesthesia in carotid endarterectomy. Am Surg 1989; 55: 656-9.

15. McCarthy RJ, Nasr MK, McAteer P, et al. Physiological advantages of cerebral blood flow during carotid endarterectomy under local anaesthesia. A randomised clinical trial. Eur J Vasc Endovasc Surg 2002; 24: 215-21.

16. Prough DS, Scuderi PE, McWhorter JM, et al. Hemodynamic status following regional and general anesthesia for carotid endarterectomy. J Neurosurg Anesthesiol 1989; 1: 35-40.

17. Takolander R, Bergqvist D, Hulten U, et al. Carotid artery surgery. Local versus general anaesthesia as related to sympathetic activity and cardiovascular effects. Eur J Vasc Surg 1990; 4: 265-70.

18. Tuman KJ, McCarthy RJ, March RJ, et al. Effects of epidural anesthesia and analgesia on coagulation and outcome after major vascular surgery. Anesth Analg 1991; 73: 696-704.

19. Nishimori M, Balantyne AC, Low JHS. Epidural pain relief versus systemic opioid-based pain relief for abdominal aortic surgery. Cochrane Database Syst Rev 2006; 3: CD005059.

20. Yeager MP, Glass DD, Neff RK, Brink-Johnson T. Epidural anesthesia and analgesia in high-risk surgical patients. Anesthesiology 1987; 66: 729-36.

21. Marrocco-Trischitta MM, Tiezzi A, Svampa MG, et al. Perioperative stress response to carotid endarterectomy: the impact of anesthetic modality. J Vasc Surg 2004; 39: 1295-304.

22. Guay J. Regional or general anesthesia for carotid endarterectomy? Evidence from published prospective and retrospective studies. J Cardiothorac Vasc Anesth 2007; 21: 127-32.

23. Rerkasem K, Rothwell PM. Local versus general anesthesia for carotid endarterectomy. Cochrane Database Syst Rev 2008; 4: CD000126.

24. Finocchi C, Gandolfo C, Carissimi T, Del Sette M, Bertoglio C. Role of transcranial doppler and stump pressure during carotid endarterectomy. Stroke 1997; 28: 2448-52.

25. Jacob T, Hingorani A, Ascher E. Carotid Artery Stump Pressure (CASP) in 1135 consecutive endarterectomies under general anesthesia: an old method that survived the test of times. J Cardiovasc Surg 2007; 48: 677-81.

26. Moritz S, Kasprzak P, Arlt M, Taeger K, Metz C. Accuracy of cerebral monitoring in detecting cerebral ischemia during carotid endarterectomy. Anesthesiology 2007; 107: 563-9.