High thoracic epidural anesthesia in patients with synchronous carotid endarterectomy and off-pump coronary artery revascularization

Visoka torakalna epiduralna anestezija kod bolesnika sa istovremenom karotidnom endarterektomijom i off-pump revaskularizacijom miokarda

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Abstract

Background/Aim. In order to reduce the risk of cerebrovascular insults (CVI), the latest recommendations suggest that carotid endarterectomy (CEA) is strongly indicated in patients scheduled for coronary surgery when significant carotid artery stenosis is symptomatic and/or bilateral. The best results are obtained in small studies with CEA performed immediately prior to off-pump coronary bypass (OPCAB). We present 16 consecutive patients who underwent synchronous CEA and OPCAB under general anesthesia combined with high thoracic epidural anesthesia (TEA) in order to evaluate the safety and potential benefits of such anesthetic management. Methods. A total of 16 consecutive patients scheduled for simultaneous CEA and OPCAB with no contraindication for TEA were enrolled in the study. All the patients were anesthetized with TEA combined with general anesthesia. Early extubation was planned in all the patients for early assessment of neurological outcome. Demographics, comorbidity, quality of postoperative recovery, duration of mechanical ventilation, successful early extubation, outcome, length of Intensive Care Unit (ICU) and hospital stay were recorded. Results. Only two patients did not fulfill the criteria for early extubation. The average duration of mechanical ventilation for patients who fulfilled criteria for early extubation was 87.9 ± 85.0 (0–255) min. Five (31.25%) patients were extubated in the operating theater at the end of surgery. There were no deaths, nor neurological complications of TEA. Seven (43.7%) patients had at least one of the postoperative complications considered significant. None of them had CVI. None of the early extubated patients was reintubated or had postoperative respiratory failure. Conclusion. Our study revealed that a combination of general anesthesia with TEA appears to be good choice in synchronous CEA and OPCAB due to advantages of early extubation and early neurological assessment. Larger studies are necessary to determine real benefits on both short and long-term outcomes of such anesthetic management in synchronous CEA and OPCAB.

Key words: endarterectomy, carotid; coronary artery bypass; comorbidity; anesthesia, epidural; postoperative complications.
Introduction

Cerebrovascular insult (CVI) is among grim complications following cardiac surgery with the overall incidence of 2%\(^1\). Significant stenosis of the carotid artery has been recognized as the most powerful predictor of perioperative stroke after cardiac surgery\(^2,3\). There is a 14% risk of perioperative stroke in patients with severe carotid artery disease undergoing coronary artery bypass grafting (CABG), and the stroke rate remains 4% per year for the first 4 years after coronary revascularization\(^4,5\). Significant carotid artery stenosis is present in near 20% of patients scheduled for CABG\(^6\). The incidence can be even higher in those having left main coronary artery disease\(^7\). Despite being significant risk factors for developing perioperative CVI, carotid artery disease is estimated to be direct cause in only 40% of the cases\(^7\). Also, CEA performed in nonrevascularized patients with severe coronary artery disease has been shown to be associated with mortality rate as high as 20%; myocardial infarction has been found to be responsible for 50% to 75% of all late deaths in this patient population\(^1\).

Many studies have identified risk factors for stroke during coronary artery operation, including hypertension, age, diabetes, carotid bruit, previous transient ischemic attack, and prior stroke\(^8,9\). In addition, prolonged cardiopulmonary bypass (CPB) time also has been reported to be associated with a higher risk of stroke\(^8,10\). In addition to CPB time, also, surgery technique brings some additional risk factors, and most of them are related to the use of extracorporeal circulation. Of note, CVI may be considered as one of the consequences due to cardiac or aortic manipulation during the procedure\(^11\).

Current recommendations for carotid revascularization in patients undergoing CABG surgery are based on expert opinion, since there is a lack of strong evidence to guide decision-making\(^12,13\). The latest recommendations suggest that CEA should be strongly considered in patients scheduled for CABG surgery with concomitant significant symptomatic and/or bilateral carotid artery stenosis\(^14,16\).

Up to now, encouraging results have been shown in small series of patients, where CEA had been performed immediately prior to off-pump coronary bypass (OPCAB), when compared to synchronous CEA with standard CABG surgery\(^17\). This may be related to the fact that OPCAB by definition avoids CPB, as one of the most important contributing factors for stroke\(^1\). However, available data are scarce on which surgical or anesthetic technique is superior for this specific patient population at high risk and individual approach has been strongly suggested.

We presented a series of 16 consecutive patients with simultaneous CEA and OPCAB, operated on under general anesthesia combined with high thoracic epidural anesthesia (TEA). We sought to determine the safety and potential benefits of such anesthetic management.

Methods

From February 2002 until October 2005, after local Ethical Committee approval, a total of 16 consecutive patients scheduled for simultaneous carotid endarterectomy and off-pump coronary bypass surgery (OPCAB) were included in the observational study at the Dedijer Cardiovascular Institute.

All the patients indicated for simultaneous carotid endarterectomy and CABG, with no contraindication for TEA were considered eligible for the study.

All the patients had significant carotid stenosis of more than, or equal to 70% on preoperative carotid duplex scanning. They were either symptomatic, had bilateral significant carotid stenosis, or were classified as having an unstable atherosclerotic plaque.

All the patients were anesthetized with high TEA combined with general anesthesia. Early extubation was planned in all the patients for early assessment of neurological outcome.

Exclusion criteria for the study were: acute infections, myocardial infarction within one month before surgery, coagulation disorders, and emergency surgery.

Preoperative assessment and medication were standard for all the patients. Induction of anesthesia was done intravenously, with midazolam (up to 5 mg), bolus doses of propofol, fentanyl and pancuronium. For the maintenance of adequate depth of general anesthesia sevoflurane was used, together with intravenous bolus doses of fentanyl and pancuronium.

Ključne reči: endarterektomija; aa. carotis; aa. coronariae; premoščavanje; komorbiditet; anestezija; epiduralna; postoperativne komplikacije.
Epidural catheter was placed at Th2-Th3 or Th3-Th4 level, 30 min before surgery, or at least 2 h before the first dose of heparin was used. After the test dose, bolus of bupivacaine with fentanyl in different concentrations (0.125%, 0.25%, or 0.5%) was used followed by continuous infusion of the same local anesthetic with fentanyl, usually at the 0.125% or 0.25% concentration. The rate of continuous infusion was adjusted accordingly; usually, it was 5–10 mL per hour during the operation.

Postoperative analgesia was mainly based on continuous epidural infusion of local anesthetic (0.125% bupivacaine with fentanyl). According to the study protocol, it was planned to take out epidural catheter at the end of the second postoperative day, two hours before the prescribed dose of the low-molecular weight heparin.

Antithrombotic therapy was stopped before elective surgery (ticlopidine and clopidogrel 10 days before the operation). Aspirin was not stopped in all patients, and was not considered as the contraindication for TEA.

Coagulation studies – prothrombin time (PT), partial thromboplastin time (PTT), international normalized (INR) and platelet count, were performed in all the patients preoperatively. Any detected abnormality was considered as contraindication for TEA and exclusion criteria for the study.

Heparin was used in standard intraoperative doses, including 50 mg i.v. bolus dose just before carotid artery was clamped, and was neutralized with protamine after finishing the last proximal anastomosis.

Demographics, comorbidity, pre- and intraoperative therapy, operation time, ischemic time and number of grafts were noted.

Quality of postoperative recovery, duration of mechanical ventilation, as well as successful early extubation, outcome, length of Intensive Care Unit (ICU) and hospital stay, were also noted. Any postoperative complication, including cardiovascular, respiratory, neurological, gastrointestinal, as well as possible infections, were followed.

Surgery technique

Vascular surgeon performed CEA before sternotomy. No shunt was used. The neck wound was left open until heparin was reversed with protamine after CABG. The wound was closed after CABG and after reversing heparin, with or without drainage.

Cardiac team performed coronary artery surgery. OPCAB was performed through median sternotomy. Different mechanical stabilizers were used (The Octopus or Starfish). No intracoronary shunts were used during the procedure.

Results

All except one patient included in this study were man, 61.9 ± 7.3 years of age (range from 50–70 years).

Demographic characteristics of the patients are shown in Table 1.

<table>
<thead>
<tr>
<th>Characteristics of the patients</th>
<th>Mean value ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>81.3 ± 14.7</td>
<td>60–106</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.0 ± 8.3</td>
<td>150–187</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.7 ± 4.1</td>
<td>20.8–32.7</td>
</tr>
<tr>
<td>EF (%)</td>
<td>43.1 ± 12.0</td>
<td>15–60</td>
</tr>
<tr>
<td>Euroscore</td>
<td>5.3 ± 1.8</td>
<td>3–9</td>
</tr>
<tr>
<td>NYHA class</td>
<td>2.8 ± 0.6</td>
<td>2–4</td>
</tr>
</tbody>
</table>

BMI – body mass index; EF – ejection fraction; NYHA – New York Heart Association.

Preoperative risk factors for all the patients are shown in Table 2.

<table>
<thead>
<tr>
<th>Preoperative risk factors of the patients</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>12 (75)</td>
</tr>
<tr>
<td>Angina</td>
<td>15 (93.8)</td>
</tr>
<tr>
<td>MI</td>
<td>7 (43.8)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>5 (31.3)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>6 (40.0)</td>
</tr>
<tr>
<td>Smoking</td>
<td>8 (53.3)</td>
</tr>
<tr>
<td>COPD</td>
<td>2 (13.3)</td>
</tr>
<tr>
<td>CVI</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>CEA (previous)</td>
<td>4 (24.8)</td>
</tr>
<tr>
<td>Preoperatively symptomatic</td>
<td>8 (50.0)</td>
</tr>
</tbody>
</table>

MI – Myocardial infarction; CEA – Carotid endarterectomy; COPD – chronic obstructive pulmonary disease; CVI – cerebrovascular incident.

Preoperative β-blocker therapy was present in 9/16 (56.3%) of patients, while 8/16 (50%) were on ACE-inhibitors.

Aspirin was not stopped preoperatively in 10/16 (62.5%) of the patients.

Epidural anesthesia was adequate in all the patients. Local anesthetic in low concentration (0.25% or 0.125% bupivacaine) mixed with fentanyl, either as i.v. bolus and continuous i.v. infusion was given in 9/16 (56.3%) of the patients. The rest of the patients, 7/16 (43.7%), were given bupivacaine in higher concentration (0.5% bupivacaine as i.v. bolus, followed by 0.25% bupivacaine in i.v. continuous infusion). General anesthesia was maintained with sevoflurane in 15/16 (93.8%) of the patients.

Intraoperative hypotension treated with inotropes or vasopressors was present in 4/16 (25%) of the patients. Symptomatic bradycardia was present in 6/16 (37%) of the patients and was treated either with atropine or ephedrine.

Eversion CEA, which employs a transverse arteriotomy and reimplantation of the carotid artery, was done in 13/16 (81.3%) of the patients. Left CEA was performed in 12/16


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The average duration of the surgery was 204.1 ± 41.4 min (range from 125–300 min).

Only two patients did not fulfill the criteria for early extubation (within 6 hours from the end of the surgery). One of them had slow recovery from anesthesia and was extubated 450 min after the end of surgery. The other patient developed neck hematoma that required reexploration for bleeding in the first 2 postoperative hours. Although aspirin was not stopped preoperatively and that could contribute to hematoma development, surgical bleeding was found and hemostasis performed. After that he also developed two major postoperative complications: myocardial infarction and low cardiac output. He was mechanically ventilated for 1170 min (range from 125–300 min).

The average duration of mechanical ventilation was 178.1 ± 290.5 min. For the patients that fulfilled criteria for early extubation, average duration of mechanical ventilation was 87.9 ± 85.0 minutes (range from 0–255 min). Five (31.25%) patients were extubated in the operating theater, at the end of surgery. There were no deaths. There were no neurological complications of TEA. Seven (43.7%) of the patients had at least one of the postoperative complications considered significant (Table 3).

### Table 3

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agitation</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Infection*</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>Low CO</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Neurological deficit</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>1 (6.3)</td>
</tr>
</tbody>
</table>

*Presence of signs of systemic, respiratory and urinary infections

The patient with respiratory failure was reintubated and mechanically ventilated between the third and sixth postoperative day. He had preoperative chronic renal failure and diabetes mellitus poorly regulated postoperatively, which led to severe metabolic acidosis and respiratory insufficiency. This was the patient that had slow postoperative recovery from anesthesia and late postoperative extubation (after 450 minutes from the end of surgery).

None of the early extubated patients was reintubated or had postoperative respiratory failure.

The average stay in the ICU was 61.6 ± 43.9 hours (range 18–168 hours) and length of hospital stay was 10.5 ± 6.3 days (range 7–29 days).

### Discussion

Management of patients with severe combined carotid and coronary artery disease is controversial, thus a balanced and individualized approach is needed.

CEA performed in conjunction with CABG surgery carries increased perioperative risk. Although the latest recommendations suggest that CEA should be strongly considered in patients scheduled for CABG surgery with concomitant significant symptomatic and/or bilateral carotid artery stenosis, these cases are not the most commonly seen in everyday practice. The most frequent, severe carotid artery stenosis in this patient population is asymptomatic and unilateral. The real clinical challenge is to manage this combined arterial disease with the lowest possible adverse outcome rate.

Although carotid stenosis is an important risk factor for development of perioperative stroke, increasing evidence suggests that the most common single cause of post-CABG stroke is embolisation of atherosclerotic material from the atheromatous aortic arch during surgical manipulation. As a consequence, a number of surgical strategies have been developed to reduce the risk of macroembolisation during aortic cannulation, cross clamping and finishing proximal anastomoses. OPCAB may avoid many of these perioperative risks, but these potential benefits have to be balanced with the possible drawbacks.

Available data confirm that the 30-day reported death/stroke rate is significantly lower when CEA is performed immediately prior to OPCAB surgery (1.0%) as compared to reported risks for patients undergoing synchronous CEA and CABG (30-day death/stroke 8.7%). One possible interpretation may be that the lower stroke risk in patients undergoing CEA and OPCAB may be attributable to a minimal manipulation with aorta without cannulation (less potential for embolisation), rather than to effects of the prophylactic CEA. However, very low procedural risk observed following synchronous CEA and OPCAB might simply reflect small numbers and selective reporting.

Importantly, little data exist on anesthetic techniques that would be the most beneficial for this high risk and particular patient population.

The landmark general anesthesia versus local anesthesia for carotid surgery, (GALA) trial (3,526 patients, enrolled in 95 centers in 24 countries), randomized patients with CEA, to general anesthesia or local anesthesia. This study revealed that the applied anesthetic technique itself was not associated with a significant difference in the trial endpoint, which was a composite of perioperative death, myocardial infarction, and stroke (4.8% for general and 4.5% for local anesthesia, respectively).

Additionally, a recent large single-center “real-world experience” trial failed to demonstrate any outcome advantage of local anesthesia.
To our knowledge, there are no studies examining effects of different anesthetic techniques in simultaneous CEA and coronary artery surgery, including OPCAB.

Chakravarthy et al. 26, published two case reports of CEA and OPCAB, performed in regional anesthesia for both CEA and OPCAB, during the simultaneous procedure. Authors believe in the advantage of having conscious patients during carotid surgery, that offers possibility of making rapid diagnosis of transient cerebral ischemia and avoiding any further damage by prompt intervention. At the same time, TEA is an alternate technique in which the benefits of epidural anesthesia are retained without the adverse effects of general anesthesia 27. Although performed without problems in our series of patients, this the anesthetic choice may be demanding and not without limitations. According to available published literature, 16 consecutive patients presented in our study are the only group of patients with simultaneous CEA and OPCAB surgery operated on under combined general and TEA, in order to achieve early extubation and early neurological assessment. Almost 90% of our patients were, due to anesthetic choice, extubated early, within two hours from the end of the surgery. Five of them were fully awake and extubated in the operating theater. None of the early extubated patients experienced respiratory failure and reintubation.

Our group of patients was assessed preoperatively as the high-risk group (Euroscore for the group was over 5), with expected mortality rate of more than 10% 28. Also, all the patients scheduled for simultaneous procedure had significant carotid stenosis of more than or equal to 70%. Half of them had symptoms and the rest bilateral significant carotid stenosis, or were classified as having an unstable ath- erosclerotic plaque. It is well known that these patients’ characteristics correlate with bad outcome 1. In spite of these risks, there were neither deaths nor cerebrovascular insults in our study. Only two patients were diagnosed myocardial infarction, and only one of them was experiencing prolonged recovery. We believe that these results can be considered as much better than it was anticipated.

TEA proved to be good choice of anesthesia for this patient population. The patients were hemodynamically stable; anesthesia was adequate, early recovery was achieved in the majority despite of high perioperative risk. There were no complications related to the anesthesia itself.

Although there was no mortality, seven patients had at least one of the postoperative complications considered as significant. This explains rather long ICU and hospital stay (62 h and nearly 10 days, respectively).

The incidence of postoperative atrial fibrillation in patients with simultaneous CEA and OPCAB was as high as 46% in one study 21, while the expected incidence of this complication after CABG was around 20%. In our study, only 3 (18.8%) of the patients had postoperative atrial fibrillation, which is the expected incidence in general cardiac surgery population. Nevertheless, this incidence is still higher in comparison with data published in studies referring to positive effects of TEA in cardiac surgery 1. However, the number of patients in our study is too small for drawing out any firm and general conclusions regarding the occurrence of postoperative atrial fibrillation.

There are several limitations of our study that should be discussed. This study was observational, with a small number of included patients. However, these patients were consecutive and enrollment lasted for 4 years, because the indication for simultaneous carotid and OPCAB was not made often. Also, these are the results of only one cardiac surgery team, which was involved in the OPCAB program. Secondly, neuroprotective effects of our approach cannot be assumed, due to a small number of patients and incomplete postoperative neurologic evaluation. According to our study protocol, only obvious, significant neurologic deficits could be noted. Again, a limited number of patients prevents drawing out more conclusions on the effects of the surgical technique, as well as the choice of anesthesia on patient outcome. However, we presumed that combining two techniques, both in surgery and anesthesia, that have known advantages in this patient population, may lead to better outcome for a high-risk group of patients involved in this study. Lastly, since the patients were followed-up until the end of their hospital stay, long-term complications and outcome related to the OPCAB procedure (graft closure, cerebrovascular incidents, long term mortality) could not be determined.

**Conclusion**

Our study revealed that a combination of general anesthesia with TEA appears to be good choice for simultaneous CEA and OPCAB. This anesthetic approach offers several advantages, including early extubation and early neurological assessment, the possibility of early re-exploration if necessary, but also, hemodynamic stability, comfort for the patients, and possibility for the implementation of the fast track protocol. Even in this high-risk group of patients, the results were encouraging. Larger studies are necessary to determine real benefits on both short and long-term outcome of such anesthetic management in simultaneous CEA and OPCAB.

**References**


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