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General anesthesia management in carotid endarterectomy surgery: a single center experience

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Abstract
Carotid endarterectomy (CEA) is an effective surgery which is applied in order to reduce the risk of stroke associated with severe stenosis of the carotid artery. Anesthesia management is important in these patients due to high incidence of cardiovascular disease and studies are in progress for ideal anesthesia management. In this study, we aimed to share our experience in carotis endarterectomy and evaluate the clinical outcomes and review retrospectively.
Patients informations were obtained from the patients and anesthesia records. Age, ASA physical status, Mallampati score (MP), anesthesia and surgery duration, ICU and discharge time, blood transfusion rate, anesthetic and analgesic drugs, invasive procedures, complications, smoking, stenosis side and ratio, comorbid conditions of patients and drugs were recorded. The mean age of patients was 67.19±1.07 (33-98). It was evaluated that 44 patients (61.2%) were ASA II, 28 patients (38.8%) were ASA III. It was recorded that mean duration of anesthesia was 226.25 ± 37.99 min, duration of surgery was 195.83±38 min, ICU stay was 2.45 ± 2.52 days and hospital stay time was 5.23 ± 2.77 days. 29 of patients (40.3%) were smokers and 7 of patients (9.7%) were identified as secondary smokers. The mortality rate was 6.9% (5 patients). Clinical experience and outcome data from our study are consistent with the literature. In CEA surgery, anesthetic technique that is safe enough to guide the evidence is not there yet. Experience of the anesthesiologist and the surgeon as surgical anesthetic management of CEA is an important point to be noted that the current developments in the patient's characteristics and monitoring.

Keywords: Carotid endarterectomy, general anesthesia, vascular surgery, anesthesia management

Introduction

Carotid endarterectomy (CEA) is an effective surgery which is applied in order to reduce the risk of stroke associated with severe stenosis of the carotid artery [1,2]. Atherosclerosis is associated with high mortality and morbidity and the most frequent reason for stroke which is one of the most important cause of carotid artery stenosis [3]. It has been reported to decrease stroke and mortality rates of symptomatic and asymptomatic patients administered CEA. The purpose of CEA is remove successfully the atherosclerotic plaque in the carotid artery and repair without complications [4]. It can be many complications in CEA; especially stroke and embolism, respectively hematoma, cranial nerve dysfunction, cerebral hemorrhage and myocardial infarction. Many techniques and devices have been developed to prevent ischemia and embolism which are complications of CEA and to screen neuromonitorization.

Although, general anesthesia is administered in many centers, local anesthesia or regional anesthesia have been administered in awake patients to reduce morbidity and mortality, though an ideal method for superiority could not be determined with certainty for anesthesia management of CEA. Anesthesia management is important in these patients due to high incidence of cardiovascular disease and studies are in progress for ideal anesthesia management. The purpose of this study is to evaluate the clinical outcomes and review retrospectively 72 patients who underwent CEA with general anesthesia in the years 2005-2015. It is aimed to guide for many kind of clinical conditions in anesthesia management of carotid endarterectomy.

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Materials and Methods

Between January 2005 and December 2015, 72 patients, who underwent CEA under general anesthesia and ages between 33 and 98, included into the study after taken of Inonu University Medical Faculty Ethics Committee approval (Ethics committee protocol code: 2014 / 192-03.12.2014). Patients informations were obtained from the patients and anesthesia records. Age, ASA physical status, Mallampati score (MP), anesthesia and surgery duration, ICU and discharge time, blood transfusion rate, anesthetic and analgesic drugs, invasive procedures, complications, smoking, stenosis side and ratio, comorbid conditions of patients and drugs were recorded.

Statistical Evaluation

SPSS (Statistical Package for the Social Sciences, Inc., Chicago, IL, USA) 13.0 software package was used in statistical analysis of datas. Number, percentages, averages

and standard deviations were used for defining the data. The recorded data is obtained by full inventory sampling.

Results

General anesthesia was administered to all patients. The mean age of patients was 67.19±1.07 (33-98). It was evaluated that 44 patients (%61.2) were ASA II, 28 patients (%38.8) were ASA III. MP scores of patients were 50 (%69.4) and 22 (%30.6) MP I and MP II, respectively. It was recorded that mean duration of anesthesia was 226.25 ± 37.99 min, duration of surgery was 195.83±38 min, ICU stay was 2.45 ± 2.52 days and hospital stay time was 5.23 ± 2.77 days. Anesthetic, analgesic and other preoperative drugs are shown in Table 2.

Table 1. Demographic data

Demographic data (mean ± SD)		
Age(year)	67.19 ± 1.07	*(33-98)
ASA n(%)		
ASA II	44 (61.2%)	
ASA III	28 (38.8%)	
MP n(%)		
MP I	50 (69.4%)	
MP II	22 (30.6%)	
Total	**72 patient**	

Values as presented as mean ± SD, MP: Mallampati Score
ASA: American Society of Anesthesia * range

Table 2. Operational characteristics

Operational characteristics (mean ± SD)		
Duration of anesthesia (min)	226.25 ± 37.99	*(150-240)
Duration of surgery (min)	195.83 ± 38	*(120-390)
Duration of IMC stay (day)	2.45 ± 2.52	*(1-17)
Total hospital stay (day)	5.23 ± 2.77	*(2-17)
Blood transfusion n(%)	2 (2.8%)	
Inhaled anesthetics n(%)		
Sevoflurane	36 (50%)	
Desflurane	2 (2.8%)	
Izoflurane	34 (47.2%)	
Anesthetic drugs n(%)		
Thiopental	64 (88.9%)	
Propofol	2 (2.8%)	
Ketamine	6 (8.3%)	
Neuromuscular drugs n(%)		
Vecuronium	71 (98.6%)	
Rocuronium	1 (1.4%)	
Analgesia n(%)		
Paracetamol	67 (93.1%)	
Morphine	3 (4.1%)	
Tramadol	2 (2.8%)	
Invasive access n(%)		
Artery+central cannulation	10 (13.9%)	
Artery cannulation	62 (86.1%)	
Postoperative complications n(%)		
None	62 (86.1%)	
Infection	2 (2.8%)	
Hemorrhage	7 (9.7%)	
Laringeal nerve paralysis	1 (1.4%)	
Peroperative drug n(%)		
Ephedrine	18 (25%)	
Nitroprusside	8 (11.1%)	
Noradrenaline	1 (1.4%)	
Dopamine	1 (1.4%)	
Remifentanyl	1 (1.4%)	

Values as presented as mean ± SD, min: minutes IMC: intermediate care unit, * range

Two of patients (2.8%) required transfusion. Artery cannulation was performed 62 of patients (%86.1), both arterial and central venous cannulation were performed to 10 of patients (%13.9). 29 of patients (40.3%) were smokers and 7 of patients (9.7%) were identified as secondary smokers. The mortality rate was 6.9% (5 patients). It was learned that 52 of patients (72.2%) had preoperative ischemic attack. It was observed that laryngeal nerve paralysis developed on 1 of patients (1.4%). Carotid artery stenosis side, the degree of stenosis, CEA side, patients used drugs and comorbid diseases are shown in Table 3.

Table 3. Patient Characteristics

Patient Characteristics (mean ± SD)		
Smoking n(%)		
Yes	29 (40.3%)	
Secondary smoking	7 (9.7%)	
Carotis stenosis n(%)		
Unilateral	35 (48.6%)	
Bilateral	37 (51.4%)	
Carotis stenosis side n(%)		
Right	14 (19.4%)	
Left	21 (29.2%)	
Right+Left	37 (51.4%)	
Carotis endarterectomy side n(%)		
Right	33 (45.8%)	
Left	39 (54.2%)	
Preoperative Ischemic attack n(%)	52 (72.2%)	
Stenosis degree (%)		
Right	49.06 ± 37.68	*(25-98)
Left	61.02 ± 34.68	*(20-100)
Mortality n(%)	5 (6.9%)	
Preoperative drugs of patient n(%)		
Antihypertensive	28 (38.9%)	
Anticoagulant	8 (11.1%)	
Antidiabetic	2 (2.8%)	
Antipsychotics	1 (1.4%)	
Bronchodilator	1 (1.4%)	
Comorbid diseases n(%)		
HT	56 (62.5%)	
DM	27 (37.5%)	
CAD	13 (18%)	
COPD	1 (1.4%)	

Values as presented as mean ± SD, * range, HT: Hypertansion, DM: Diabetus mellitus,
CAD: Coroner artery disease, COPD: Chronic obstructive pulmonary disease

Discussion

The data of 72 patients who underwent CEA under general anesthesia were analyzed retrospectively. In our study, we aimed to evaluate the general main characteristics of patients and changes associated with surgery. The mean age of the patients and ASA scores were similar to other studies [5]. In the age range evaluation, it was observed that surgery was applied under the age of 40, despite being much older than 60 years.

Preoperative preparations in patients undergoing CEA are; effective treatment of coexisting diseases, further examination of the cardiovascular system and neurologic status, agent selection not cause deep sedation, maintaining

of ongoing drug therapy, required monitorization and selection of appropriate anesthetic technique. There is no consensus of a definite opinion among anesthesiologists about the superiority of the anesthesia management for CEA [6]. Furthermore these methods have no effects on mortality and morbidity [7]. Durations of anesthesia and surgery are variable for CEA with regional anesthesia (RA), local anesthetics (LA) and general anesthesia (GA). In our study, the mean duration of anesthesia was 226.25 ± 37.99 min and the mean duration of surgery was 195.83 ± 38 min. The results were similar to literature [8]. It was recorded that postoperative intensive care stay was 2.45 days ± 2.52 and discharge period was 5.23 ± 2.77 days. According to the study of Gumus et al. [5] (intensive care time 1.0 ± 0.0 days, discharge period 2.9 ± 2.1 days) longterm intensive care stay and discharge time was associated with long-term hospitalization of patients (maximum 17 days) with complications.

CEA is done under general anesthesia and surgical techniques of surgery helps to increase the chances of success. GA may reduce the risk of developing complications in cardiovascular surgery due to less stress and pain seen in patients. Watts et al. [6] argued that GA is reducing surgery time and cardiovascular complications, and keeping more stable hemodynamics [9,10]. Although unique advantages of local anesthesia and regional anesthesia (neurological status is simple and easy to evaluation, the short duration of surgery and hospital stay, lower costs), the majority of CEA surgery is overcomed under general anesthesia. In fact, in some studies it has been reported that patients who underwent CEA under local anesthesia or regional anesthesia passed to general anesthesia due to various causes (5,6%), especially fear, stress and claustrophobia in patients or surgeons who want local anesthesia [11,12]. GA is preferred in the presence of contraindications to local anesthesia, severe cardiopulmonary disease, bleeding disorders, cooperation difficulties, the anxiety and neurological deficits assets neck anatomical disorder and in cases where the patient did not want local anesthesia [13]. GA eases optimal viewing of surgery field and supply a motionless area with better visual image during CEA. Patients who are restless, anxious and claustrophobic can not tolerate RA easily during CEA. However, under GA, the assessment of neurological status is difficult due to stroke that occur during carotid clamping.

Hemodynamic instability is a factor adversely affecting perioperative mortality in patients undergoing CEA [14]. In particular, surgical trauma-induced response is associated with preoperative and postoperative clinical conditions [15]. Marrocco-Trischit and colleagues at work [16], in patients who underwent CEA under regional anesthesia or GA, at the stage of carotid clamping, showed that cortisol levels increased significantly. Ercan et al. reported that in the clamp phase, the stress response value has risen rapidly compared to baseline values. During carotid clamping period, blood pressure should be maintained at over 10-20% of the basal value. Mean arterial pressure drops due to a decrease in cerebral perfusion pressure. Therefore, the hemodynamic data of these patients should be closely monitored.

Especially in the case of CEA under GA, arterial cannulation should be performed by the opposite side. ST segment analysis with DII and V5, at least 5 channel leads electrocardiogram (ECG) and heart rate and blood pressure should be monitored instantly. In our study, artery cannulation was performed to 62 patients (86.1%), arterial and central venous cannulation to 10 (13.9%) patients. Central cannulation (for central venous pressure monitoring implementation or liquid-medicine) not performed routinely except specific cases. Central cannulation cases are the initial cases of our CEA operations.

RA frequently has been performed, recently. Hye and et al [7] reported in their study that RA for CEA is more reliable with risk of periprecedural myocardial infarction and the risk for GA is higher than RA. Siu and et al [18] demonstrated that RA is more cost effective, and should be the optimal choice when clinically appropriate. Camerani and et al [19] nshowed that shorter time to extubation and better emergence from anesthesia when total intravenous anesthesia is associated with superfacial cervical block than morphine as transition analgesia. In our institution, we only apply GA for CEA. So, in this study we offered the patients who was perfomed GA for CEA.

For the patients CEA under general anesthesia with the clamping, the evaluation of the adequacy of cerebral perfusion can be monitored with variety of techniques, despite the superiority of some techniques there is no commonly acceptable method or device. Clamping time, systolic blood pressure values and stability have got important role for the clamping ischemia during carotid surgery [20]. In awake patients who underwent CEA under local anesthesia the neurological evaluation of consciousness is regarded as the gold standard. Neurological evaluation considered to be equivalent to the circle of The stump pressure is equivalent to Willis collateral perfusion pressure, and measuring of this pressure may give information about cerebral perfusion pressure. Until recently, monitoring of the level of consciousness and perioperative cerebral ischemia with Bispectral Index (BIS) monitoring is considered to be unreliable. For this reason, recently a simple and reliable transcranial cerebral oximetry is a noninvasive method used for the detection of acute cerebral ischemia and with this method mild psychological changes can be estimated [21]. For the time being, multimodal approach for the neurological monitoring is preferred [22].

For the majority of our carotid surgery patients (88.9%) undergoing anesthesia induction, the thiopental is preferred

as Miller's described [23]. In accordance with the literature in inhalation anesthesia, usually isoflurane (47.2%) or sevoflurane (50%) is preferred [24]. In recent years, the selection of appropriate patients with standard surgical techniques and effective monitoring in patients undergoing CEA cerebral surgery; the risk of perioperative complications are significantly decreased. During the CEA it may be encountered with many complications, especially stroke and embolism. Relatively frequent postoperative arterial blood pressure changes can cause high mortality of cerebral hemorrhage. If perioperative stroke excluded; myocardial ischemia is responsible for the majority of fatal perioperative and postoperative complications during the CEA [25]. Consistent with the literature, in our patients, postoperative bleeding due to anticoagulant and heparin use were very rare (9.7%) [9]. When the dissections are performed, superior level of thyroid artery or trauma during the clamping of the carotid artery may causes dysfunction of the laryngeal nerve. This prevents the emergence of high sound tonality [26]. In our study, laryngeal nerve paralysis was seen in only one patients with (1.4%).

Our study showed that in 51.4% of patients with bilateral stenosis, which is more than the degree of stenosis of the left side and the left side was more common practice in the CEA (54.2%) were identified. Similar to our study, Gümüş et al [5] in their study, the left side of the CEA application rate was reported as 57.1%.

Hypertension (43-69%), diabetes mellitus (8-40%) and high smoking rates, leads to increased mortality even in experienced hands [27]. In our study comorbid disease and smoking rates are consistent with the literature and identified as high rates [28]. Until the morning of surgery, antihypertensive and anticoagulant drugs, should be continued for these patiennts. Discontinuation of these drugs causing myocardial and cerebral ischemia and may increase morbidity and mortality [23]. The use of regular antihypertensive ratio was 38.9%, the use of regular anticoagulant was 11.1% and the use of antidiabetic drugs ratio was 2.8% in our study patients.

This study have several limitations. First, its retrospective nature as some information regarding perioperative management might be recorded in the anesthesia charts. Second, the number of patients in the study could have been more, but the total number of patients in our clinic did so. Third, the sample sizes of the patients with different comorbid conditions were small to obtain statistically relevant results and a large multi-center prospective randomized study would be necessary to confirm the conclusions of our study.

Conclusion

Clinical experience and outcomes of our study are consistent with the literature in which was performed general anesthesia. In CEA surgery, there is no anesthetic technique which is entirely safe yet. Experience of anesthesiologists and surgeons is important for the current developments in the patient's characteristics and monitorization in management of CEA. Further studies are needed to determine the most appropriate technique.

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