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Surgery of the Carotid Artery : Local Anaesthesia Versus General Anaesthesia

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Key words. Carotid endarterectomy ; shunt ; local anaesthesia.

Abstract. *Objective :* Carotid artery surgery is safely and commonly performed under general, regional or local anaesthesia. The aim of the study was to compare local and general anaesthesia in carotid artery surgery in order to establish whether differences exist in terms of peri-operative results, use of intra-operative shunts and costs.
Methods : We retrospectively reviewed the data on 426 patients who underwent carotid endarterectomy with either local or general anaesthesia at our institution over a four-year period. All available clinical, pathologic and postoperative data were reviewed and analyzed for postoperative results. Surgical indications, outcome, operative techniques, and complications were compared.
Results : A total of 306 carotid endarterectomy operations under local, and 127 under general anaesthesia were performed and analyzed. Groups were similar in terms of age, sex and pre-operative risk factor distribution. The local anaesthesia group was associated with a lower incidence of shunt placement and operative time when compared to the general anaesthesia group. Postoperative intensive care unit requirement, hospital stay and costs were also lower with local anaesthesia. Significant difference in neurological complications and mortality rate was not observed between the two groups.
Conclusion : Carotid endarterectomy performed under local or general anaesthesia is associated with low morbidity and mortality rates. Local anaesthesia enables the surgeon to assess the neurological status during the procedure. It is also associated with decreased shunt usage, decreased operative time and, in high risk patients, lower intensive care unit requirement and hospital stay.

Introduction

Safety and efficacy of the carotid endarterectomy (CEA) for the prevention of stroke in patients with high-grade carotid artery stenosis is very well established. The operation can be performed under general or local anaesthesia, depending on the familiarity of the surgeon with the procedure, even though the current general opinion is that neither of the techniques has major superior advantages over the other (1, 2). On the other hand, the proportion of CEA procedures performed under local anaesthesia (LA) has increased, especially in the past two decades. Various series using LA for CEA for the treatment of carotid artery stenosis have been reported in the literature in an attempt to decrease the risk of potential catastrophic postoperative complications (1, 2, 3).

The aim of this study was to assess and compare the CEA procedures performed under LA with the CEA performed under general anaesthesia (GA), whether the LA technique is associated with a lower incidence of postoperative morbidity and mortality and to determine whether there is an outcome difference in this particular group of patients in connection with the anaesthesia technique.

Methods

We retrospectively reviewed the data on 426 patients (302 males and 124 females with a mean age of 63.4 ± 7.8, range 52-81) who underwent elective carotid artery surgery via either local or general anaesthesia at our institution over a four-year period, from November 2000 to March 2005. A CEA procedure was carried out in all symptomatic patients with a radiological diagnosis of 70% carotid artery stenosis and in asymptomatic patients with a stenosis of more than 80%. In patients with bilateral carotid artery stenosis, endarterectomy priority was determined according to the degree and/or the side of the symptoms. Patients were divided into two groups : CEA performed under LA and CEA performed under GA. Exclusion criteria were concomitant additional revascularization procedure (subclavian steel syndromes, aorto-iliac and infra-inguinal occlusive diseases) and conversion of the LA to GA due to the anxiety of the patients. Clinical assessment, chest X-ray film, electrocardiogram and biochemical analysis were performed as an initial diagnostic work-up. Doppler ultrasonography (USG) scanning and/or angiographic evaluation were the modalities used in all patients to

establish a definitive diagnosis and determine the collateral circulation status especially of those patients with bilateral carotid artery stenosis. Further investigation, including myocardial perfusion scintigraphy, respiratory function tests and coronary artery angiography, were undertaken as needed for the assessment of any other clinical abnormalities. The choice of the anaesthesia technique primarily depended on the preference of the staff physician after consultation with the anaesthesiologists and the consent of the patient. Three hundred and six CEA procedures were performed under LA whereas there were 127 under GA. Comparisons between the LA and GA groups were fashioned with respect to preoperative risk factors, postoperative complications, and peri-operative haemodynamic variability.

All continuous data are expressed as ± standard error of the mean and categorical data are reported as a percentage. Continuous data were compared by Mann-Whitney-U and paired samples T tests, and categorical data by the chi-square test. Statistical significance was indicated by a p value of < 0.05.

Anaesthesia and Surgical Technique

All the patients received 0.5 mg/kg of diazepam as premedication. During the surgery systolic blood pressure ≥ 150 mmHg was desired and pressures above 200 mmHg and below 100 mmHg were not allowed during or after the operations.

Local anaesthetic protocol consisted of local infiltration with 2% lidocaine. Approximately 10-20 mL of lidocaine was used to infiltrate the skin incision site anterior to the sternocleidomastoid muscle. An additional 5-10 mL of lidocaine was used to facilitate further operative dissection around the carotid artery. Additional intravenous sedative agents were not used except for analgesics. All the patients were closely monitored throughout the procedure by talking and response to the commands. Neurological assessment was performed at the time of the carotid test (clamping of the carotid artery for one minute duration) and then the operation continued with appropriate measures if required. A positive clamp test was identified as a decrease in consciousness, deterioration of the co-operation and signs of neurological deficit. Furthermore, the motor function of the contralateral limb was closely monitored. Carotid artery shunting was performed in those patients who exhibited inadequate response to the commands and/or who developed global or focal deficit during the test clamp period.

In patients undergoing CEA using GA, following premedication and induction with fentanyl and propofol, orotracheal intubation was performed. Standard general anaesthetic protocol included thiopental sodium-isoflurane and nitrous oxide with fentanyl infusion. End tidal pCO_2 was maintained between 35-40 mmHg. Routine electro-encephalographic (EEG) monitoring was used for all the patients. Shunt indications during GA included contralateral total carotid occlusion, recent ipsilateral stroke or abnormal EEG measures.

Operations were performed by standard CEA techniques. The carotid sinus was anaesthetized with 2% lidocaine prior to manipulation of the carotid arteries. A standard dose of 5000 IU intravenous heparin was administered before carotid clamping. Patch angioplasty was performed if the internal carotid artery diameter was less than 5 mm or the arteriotomy was extended in the internal carotid artery.

After the operation all patients were taken to the postoperative care unit and closely monitored for arterial blood pressure, heart rate, pulse oximetry and neurological status for four hours and then taken to the ward. Haemodynamically and neurologically unstable patients were transported to the intensive care unit (ICU) for close observation. All patients were evaluated daily by neurology staff until discharge and reviewed with clinical and Doppler USG examinations at 3 months, 6 months and 1-year follow-up.

Neurological events were classified as minor and major neurological deficits. Minor neurological deficits included transient ischaemic attacks and any other neurological problems that resolved within 48 hours. Nonlateralizing sequelae, cranial nerve involvement and lacunar states were also accepted as minor deficits with promising outcome if the Rankin scores were ≤ 2. Major neurological deficits were defined as those deficits that lasted beyond 7 days. Motor hemiparesia and hemiplegia, sensorimotor deficits and a Rankin score of ≥ 3 were also bad prognostic signs.

All the patients received anticoagulation therapy in the first postoperative day and then anti-aggregant agents for a life-time period.

Statistical analysis was performed by using SPSS 11.0. All continuous data are expressed as ± standard error of the mean and categorical data are reported as a percentage. Continuous data were compared by Mann-Whitney-U and paired samples T tests, and categorical data by the chi-square test. Statistical significance was indicated by a p value of < 0.05.

Results

The series included 426 patients who had carotid artery disease. Sixteen patients were excluded from the analysis because of the concomitant nature of CEA and another revascularization procedure. Intra-operative anaesthetic modality change and conversion to GA occurred in five patients because of their anxiety. These patients were also excluded from the analysis. LA was used in 300 patients for 306 CEA procedures whereas the GA

Table I

Comparison of demographic characteristics, clinical symptoms, and comorbidities of the two anaesthetic groups

Variable	Local anaesthesia	General anaesthesia
Patients	300	105
Endarterectomies	306	127
Age	62,3 ± 7,9	64,1 ± 5,6
Male gender	261	83
Female gender	39	22
Asymptomatic	193	61
Symptomatic	102	44
Stroke	22	11
TIA	77	20
Amaurosis fugax	11	2
CAD	104	42
CHF	18	5
History of MI	36	6
Smoking	211	58
Hypertension	235	73
Diabetes Mellitus	79	48

TIA, transient ischaemic attack ; CAD, coronary artery disease ; CHF, congestive heart failure ; MI, myocardial infarction.

group included 105 patients who received 127 CEA procedures. Pre-operative patient demographics, presenting symptoms, pre-operative neurological status, preoperative risk factors, indications for surgery and comorbidity factors were similar between the two groups and described in Table I. The physicians were more encouraged to use LA due to the ICU occupation policy of the hospital.

Peri-operative variables ; systolic and diastolic blood pressure on admission and during the procedure, as well as inotropic or antihypertensive medications, operative time, carotid shunt usage, intensive care unit requirement and length of hospitalization, were compared between the two groups (Table II). Peri- and postoperative haemodynamic instability in terms of hypotension or hypertension that required inotropic support or intravenous antihypertensive drugs was lower in the LA group (18% vs. 42%, $p < 0.05$). Endoluminal shunt usage rate (7% vs. 76%, $p < 0.01$), ICU requirement (18 patients (6%) vs. 14 patients (13%), $p < 0.05$) and length of hospital stay (3.4 days vs. 5.2 days, $p < 0.05$) were less when compared to GA group. Mortality occurred in five patients (1%, two patients from the LA group, three from the GA group) due to stroke (one patient from the LA group, two patients from the GA group) and myocardial infarction (one patient from each group). There was no significant difference in either major or minor neurological complication rates. All the patients tolerated GA safely in terms of their pulmonary status, except one from the GA group, who died. This patient did not wake up and died on the third postoperative day. Computerized tomography (CT) demonstrated global cerebral ischaemia in the patient. The second patient developed stroke in the fourth postoperative hour and had to be re-entubated ; CT showed a large infarction at the middle cerebral artery area of the cerebrum. Right sided hemiplegia and agitation ensued in the third hour postoperatively in the patient from the LA group, who was however lost 12 hours postoperatively due to infarction at the middle and anterior cerebral artery zones of the brain. All the patients who developed major neurological events were re-explored under GA in order to rule out surgical site related complications ; however, there was no occlusive pathology at the intervention region of the carotid arteries. Myocardial infarction occurred in the second and fifth hours after the operation in the patients from the LA and GA groups, respectively. Despite intensive medical therapy, these patients could not be survived. Cardiac complications between the two groups were similar. Wound related complications such as haematoma formation, infection and bleeding were not significantly different between the groups. Postoperative complications are summarized in Table III.

Discussion

Several prospective and retrospective randomized studies have demonstrated that carotid endarterectomy is more effective than the best medical treatment in symptomatic

Table II

Peri-operative variables

Peri-operative variable	General anaesthesia	Local anaesthesia	*p*
Admission systolic blood pressure	115 ± 18 mmHg	120 ± 13 mmHg	> 0,05
Maximum intra-operative blood pressure	126 ± 27 mmHg	171 ± 19 mmHg	< 0,05
Minimum intra-operative blood pressure	112 ± 34 mmHg	142 ± 28 mmHg	< 0,05
Use of inotropes	31%	8%	< 0,01
Use of antihypertensives	29%	17%	> 0,05
Operative haemodynamic instability	42%	18%	< 0,05
Operative time	minutes	minutes	> 0,05
Use of carotid shunt	76%	7%	< 0,01
Intensive care requirement	13%	6%	< 0,05
Length of hospital stay	5,2 days	3,4 days	< 0,05

Table III

Postoperative complications

Complication	General anaesthesia	Local anaesthesia	*p*
Death	3 patients	2 patients	> 0,05
Stroke	2 patients	1 patient	> 0,05
Transient ischaemic attack	38 patients	59 patients	> 0,05
Myocardial infarction	1 patient	1 patient	> 0,05
Postoperative haemodynamic instability	22%	18%	> 0,05
Congestive heart failure/angina	18%	11%	> 0,05
Neck haematoma	15%%	13%	> 0,05
Wound infection	3%	4%	> 0,05
Cranial nerve injury	11%	9%	> 0,05

and asymptomatic patients with carotid stenosis (4). However, surgery is recommended at institutions in which the incidence of stroke is < 3% for asymptomatic and 6% for symptomatic patients (5, 6). With the refinements in surgical experience, advanced anaesthesiology and pre-, peri- and post-operative care knowledge, regardless of whether the surgeon considers himself a shunter, non-shunter or advocates local or general anaesthesia, reduction in the incidence of surgical complications is very significant (7). However, it still remains controversial as to which anaesthetic modality is superior (8).

The significant advantages of LA are reduced excessive blood pressure variability during or after surgery and the possibility of making a close neurological assessment during the operation and selective or a lesser degree of shunt usage. Hypertension following carotid endarterectomy increases the likelihood of neurological deficit (5) and lability in arterial tension required intensive monitoring and intravenous inotropic or antihypertensive drugs administration. The major worry is that patients may develop Cerebral Hyperperfusion Syndrome (CHS). Orbitofrontal pulsatile headaches, transient seizures, and intracerebral haemorrhages associated with an approximate doubling of cerebral blood flow over the baseline in the hemisphere distal to the surgically corrected carotid artery, is defined as CHS (6). The peri-operative fluctuation that is present during general anaesthesia makes this particular patient population highly vulnerable to cerebral ischaemia and ensuing neurological deficits. In this series, there was only one CHS in the LA group and three in the GA group. There is no significance between them but intensive monitoring parameters were significantly different. Only seven patients in the LA group required intensive monitoring in the post-anaesthesia care unit. In contrast, in the GA group there was haemodynamic instability in eight patients that needed more intensive monitoring. The difference was statistically significant and began during the weaning process.

The patients with carotid atherosclerosis may also possess some comorbid risk factors, which directly increase surgical morbidity and mortality rates. Although endotracheal intubation is not usually associated with significant complications, haemodynamic responses to tracheal intubation, tube suctioning and extubation may lead to myocardial ischaemia and represent a risk for patients with known coronary artery disease (9, 10). Although the advent of less invasive techniques for cardiovascular surgery has affected anaesthetic approaches, individual patients with chronic obstructive pulmonary disease may vary in their susceptibility to endotracheal intubation. Reduced respiratory functions leading to delayed ambulation is a well documented problem in this particular patient population.

Most institutions base their anaesthetic choice on tradition or habits, more than on concrete scientific data. In our institution, the choice depends on substructural factors. There is no well organized intensive care unit specifically arranged for vascular surgery patients and there are adequate beds in the general intensive care unit. Therefore, when the anaesthesia choice is GA, the hospital stay of the patients lengthens. After using LA more commonly than GA, the number of operations significantly increased. Because of the early excellent result of LA, CEA under GA was a less preferable surgical technique. Thus, we believe that the avoidance of endotracheal intubation, especially in patients with comorbidity factors, offers significant benefits. At least they would have the chance that operating would reduce morbidity and mortality for them.

Although many methods, including transcranial Doppler USG, stump pressure measurement, peri-operative EEG and somatosensorial evoked potentials, have been proposed to monitor the level of cerebral perfusion during arterial clamping, there is no established consensus as to which is the superior technique. Hafner and Evans reported that 86% of patients with stump pressures less than 50 mmHg would have been shunted unnecessarily (11). When GA is adopted, EEG and/or

stump pressure are two of the more effective monitoring methods during carotid cross clamping. Operative EEG monitoring is a more sensitive guide than stump pressure for selective carotid shunting and is a reliable predictor in most, but not all, cases of cerebral ischaemia. Stoughton and colleagues reported a significant number of false positive (6.7%) and false negative (4.5%) results in the detection of neurological deficits when EEG monitoring was compared with mental status evaluation in the awake patients (12).

The most obvious advantage of local anaesthesia is the avoidance of unnecessary shunt placement. The advocates of local anaesthesia stress the fact that mental status evaluation during CEA remains the gold standard with which all other methods of monitoring should be compared and it allows rapid detection of cerebral ischaemia and immediate insertion of a shunt (13). LA enables awake cerebral monitoring and is associated with reduced neurological complications due to selective shunt usage. On the other hand, there is no cause-effect relationship that clarifies this lesser degree of shunt usage. It is not apparent to the surgeon when an operative stroke occurs. It may be prior to, during, or after shunt placement. Therefore, a certain percentage of neurological deficits must be unrelated to the type of technique used (14). It has been demonstrated previously that even patients with total occlusion of the contralateral carotid artery will rarely suffer neurological injury during routine clamping of the opposite carotid during endarterectomy without shunt (5).

The reason that many surgeons do not prefer CEA under LA is because it is not comfortable and provides a lesser degree of meticulous technique in an awake and restless patient. Increasing surgical experience prevents this difficulty. Other perceived disadvantages of LA during CEA include heightened anxiety and low patient satisfaction. The results from the prospective randomized studies clearly show that patients generally have a positive experience for CEA regardless of anaesthetic technique. There were no statistically significant differences between the two types of anaesthesia in respect of anxiety, satisfaction, or overall experience (15). In our series, we needed to convert the intra-operative anaesthetic modality in five patients because of their anxiety.

In conclusion, CEA under LA has several advantages. Local anaesthesia enables the surgeon to assess the neurological status during the procedure. It is also associated with decreased shunt usage, decreased operative time and shorter length of hospital stay.

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