Journal of Clinical Anesthesia (2010) 22, 169–173

ELSEVIER

Journal of Clinical Anesthesia

Original contribution

Perioperative outcome of carotid endarterectomy with regional anesthesia: two decades of experience from the Caribbean

Seetharaman Hariharan MD, FCCM (Senior Lecturer in Anesthesiology)[a,*], Vijay Naraynsingh FRCS (Professor of Surgery)[a,b], Azad Esack MRCP (Consultant Neurologist)[c], Michael J. Ramdass FRCS (Lecturer in Surgery)[a,b], Surujpaul Teelucksingh MRCP (Professor of Medicine)[a], Aroon Naraynsingh FRCA (Consultant Anesthesiologist)[c]

[a]*The University of the West Indies, St. Augustine, Trinidad, West Indies, Trinidad and Tobago*
[b]*General Hospital, Port of Spain, Trinidad, West Indies, Trinidad and Tobago*
[c]*Medical Associates Hospital, St. Joseph, Trinidad, West Indies, Trinidad and Tobago*

Received 2 July 2008; revised 28 April 2009; accepted 19 May 2009

Keywords:
Carotid endarterectomy;
Developing country;
Regional anesthesia

Abstract
Study Objective: To evaluate the perioperative outcome of carotid endarterectomy (CEA) with regional anesthesia.
Design: Retrospective chart review of consecutive patients who underwent CEA with regional anesthesia in a 23-year period.
Setting: Operating rooms of a general hospital in a developing country.
Measurements: Demographic data, perioperative clinical data, postoperative morbidity and unplanned admissions were recorded.
Main Results: A total of 183 CEA procedures were performed. In 172 cases, CEA was done exclusively with deep cervical plexus block and local infiltration, while in 11 (6%) cases, there was a need for conversion to general anesthesia intraoperatively. Clamping of the internal carotid artery (ICA) for a three-minute period was the method used to monitor any development of neurological impairment. Perioperative complications included intraoperative seizures in one patient, intraoperative transient hemiparesis in three patients, postoperative transient hemiparesis in two patients, and intraoperative hemiplegia in one patient. One hundred fifty-three patients (83.6%) were discharged home within 24 hours, and 29 (15.8%) were discharged home in 48 hours. The hemiplegic patient had a hospital stay of 12 days. There was no perioperative mortality.

* Corresponding author. Anaesthesia and Intensive Care, Faculty of Medical Sciences, The University of the West Indies, St. Augustine, Eric Williams Medical Sciences Complex, Mount Hope, Trinidad, West Indies, Trinidad and Tobago. Tel.: +1868 662 4030; fax: +1868 662 4030.
E-mail address: uwi.hariharan@gmail.com (S. Hariharan).

0952-8180/$ – see front matter
doi:10.1016/j.jclinane.2009.05.005

Conclusions: Regional anesthesia is a safe method for CEA in a limited-resources setting, as it facilitates intraoperative clinical assessment of the effects of ICA clamping.

1. Introduction

Carotid endarterectomy (CEA) is one of the few surgeries that have undergone immense scrutiny by randomized controlled trials with respect to its indications, surgical and anesthetic techniques, overall outcome, and cost-effectiveness [1]. As the world population becomes increasingly aged, the need for this surgery is likely to increase. In developed countries, the outcome and cost-benefit of this surgery has been studied extensively [2,3]. While the main purpose of CEA is to prevent stroke, preventing perioperative stroke remains the most formidable challenge to surgeons performing this procedure. Perioperative monitoring of cerebral perfusion may be done using electroencephalography (EEG), transcranial doppler (TCD), carotid stump pressure (CSP), somatosensory evoked potentials (SSEP), or a combination of these [4]. However, most of these monitoring techniques require special equipment, technicians, and specialists to interpret the results. These are not only prohibitively expensive in third-world countries, but also time-consuming [5,6]. The benefits of local/regional anesthesia in CEA have been widely reported although most of these papers originate from developed countries [7,8]. Performing CEA in an awake patient renders the aforementioned monitoring modalities unnecessary, since clinical neurological assessment can be done before, during, and after clamping of the internal carotid artery (ICA) [9].

A recent article in the *Lancet* proposed that most developing countries lack the various facilities (including CEA) to prevent stroke in their populations [10]. There are very few reports from the developing world regarding the experience of CEA; there is one from India and a brief report from Bangladesh [11,12]. There is one report from Puerto Rico; however, this region is under the administration of United States of America [13].

With this background, a case series of CEA performed with regional anesthesia over the past two decades in a third-world Caribbean island setting, with limited equipment and simple facilities, is presented.

2. Materials and methods

A retrospective chart review of all the patients who underwent CEA during the period from January 1984 through June 2007, was done after approval from the Medical Associates Hospital, St. Joseph, Trinidad, West Indies. All of the surgical procedures were performed by a single surgeon.

2.1. Setting

Our operating rooms (ORs) are equipped with basic monitors, including pulse oximeter, non-invasive blood pressure (BP) monitor, electrocardiogram (ECG), and capnograph. Although there are provisions for invasive monitoring, these are rarely used. There are no neurological monitors available in the ORs. Junior doctors (not qualified as specialists) provide perioperative care to patients under the supervision of a senior anesthesiologist. Consultant surgeons, neurologists, and internists provide care to inpatients along with in-house junior medical officers around the clock. The hospitals also have modern laboratories facilitating most hematological and biochemical investigations.

2.2. Methods

All patients received regional anesthesia in the form of a deep cervical plexus block and supplementation with local infiltration in the surgical site. A 25 mL mixture of bupivacaine and lidocaine was prepared, to provide a final concentration of 0.25% and 1% of each drug, respectively. Of this amount, 10 to 12 mL was used for the deep cervical plexus block and the remaining amount was used for local infiltration. All patients received midazolam two mg intravenously (IV) just before the block.

Using aseptic precautions, anatomical landmarks such as the posterior border of the sternocleidomastoid, the mastoid process, and the transverse process of the sixth cervical vertebra (Chassaignac's tubercle) were marked and three to 4 mL of the local anesthetic mixture was injected at each level of the transverse processes of the 2nd, 3rd, and 4th cervical vertebrae. The remaining amount of the local anesthetic mixture was used by the surgeon to supplement local anesthesia at the surgical site. It is a routine practice of the surgeon to infiltrate one mL of 1% lidocaine in the region of carotid sinus before dissection of the carotid bifurcation.

Basic demographic data collected included age and gender of the patient. Clinical data recorded were preoperative physical status of the patient; co-morbidities; indications for surgery; type of anesthesia performed, including reasons for conversion from regional to general anesthesia; surgical procedure, including details of the clamping of the ICA; utilization of shunts; intraoperative and postoperative complications; intensive care unit (ICU) admissions, if any; hospital length of stay; and 30-day postoperative outcome for neurological status, myocardial infarction (MI), and death.

3. Results

During the study period, 183 CEA procedures were performed in 180 patients, all of whom were ASA physical status II. Of these patients, 102 (56%) were men. Their ages ranged from 53 to 88 years; the median age was 67 years.

The most common co-morbidities were essential hypertension (21%), non-insulin dependent diabetes mellitus (28%), and ischemic heart disease (33%). Indications for the CEA were transient ischemic attacks in 172 cases (94%), "stroke in evolution" in 7 (4%) cases, and as a preoperative prophylactic procedure before coronary artery bypass grafting in 4 (2%). The diagnosis was confirmed by Duplex scan in all cases, and in 18 cases further assessment was done using magnetic resonance angiography (MRA) to rule out other lesions.

A total of 172 cases underwent surgery exclusively with regional anesthesia, while there was a need for conversion to general anesthesia in 11 (6%) cases. One of the 11 patients had a tonic-clonic seizure due to intravascular injection during deep cervical plexus block and general anesthesia was immediately instituted; a shunt was used in this case. Ten patients were quite uncomfortable from the surgical retraction in the mandibular region, despite repeated local anesthetic infiltration. Before general anesthesia was induced in these patients, a three-minute trial of carotid clamping was done to establish safety when the patient was awake, after which general anesthesia was instituted; none of these patients needed shunt placement and none suffered any neurological sequelae. General anesthesia was induced with thiopental sodium 5 mg/kg, endotracheal intubation was facilitated by succinylcholine one mg/kg, and general anesthesia was maintained with halothane/isoflurane in nitrous oxide and oxygen. In this case series, none of the patients who received general anesthesia required vasoactive drugs to manage their blood pressure perioperatively.

All other patients who had regional anesthesia also underwent a three-minute clamping of the ICA and were clinically observed for any neurological impairment. Three patients developed altered consciousness and hemiparesis immediately following carotid clamping; however, they returned to their normal preoperative status once an intraluminal shunt was inserted. Thus, the shunt utilization rate of the present series is 2%. Two other patients developed mild weakness of their contralateral upper and lower limbs during the actual CEA; however, they regained function on completion of the procedure. One patient developed hemiplegia during surgery, which continued into the postoperative period. Although the patient showed some neurological improvement over several months, there was significant permanent hemiplegia. A MRA done on this patient showed a patent extracranial carotid system with an occluded middle cerebral artery and corresponding cerebral infarction.

Twelve patients experienced significant discomfort during dissection of the distal ICA. These patients required an additional 5 to 7 mL of 1% lidocaine infiltration intraoperatively. One patient had uneventful surgery during regional anesthesia but developed sudden aphasia and hemiplegia two hours postoperatively. This patient was taken for immediate re-exploration with general anesthesia, which showed acute thrombosis with complete occlusion at the surgical site. This patient had a thrombectomy with a patch closure of the carotid; no shunt was used and within three hours of re-exploration she recovered completely without any neurological deficit.

Although 90% of the patients had contralateral disease, only 6 had > 60% stenosis. All were asymptomatic, and none of these patients needed shunting. Three patients had later contralateral endarterectomy, and three are being followed up in the neurology clinic.

Postoperatively, all patients were routinely monitored with pulse oximetry, half-hourly BP readings, and hourly assessment for level of consciousness and neurologic status. Electrocardiography and cardiac enzymes were not done routinely as there was no clinical indication for these investigations in any patient in this case series.

Within 24 hours, 153 cases (83.6%) were discharged home and 29 (15.8%) stayed for 48 hours. The patient who had hemiplegia had a hospital stay of 12 days. No patient required ICU or high-dependency unit admission.

Within 30 days following the surgery, there were no deaths or MIs by clinical criteria in any patient. No patient developed stroke following hospital discharge other than the one mentioned earlier who had hemiplegia intraoperatively.

4. Discussion

The major finding of this case series is the good perioperative outcome for CEA during regional anesthesia in a setting with limited resources for intraoperative neurological monitoring. Utilization of shunts during CEA is a commonly practiced procedure. Some authors recommend routine shunting in all patients undergoing CEA, although this practice remains controversial [14]. Shunt utilization may be associated with air or thrombus embolization, local vessel trauma, clotting within the shunt, poor visualization of the end point, and increased technical difficulty of the procedure [14]. Therefore, it seems desirable that one uses shunts only for those patients who are likely to develop neurological deficits. Selective shunting seems to be a prudent practice, and it requires the assistance of intraoperative neurological monitoring.

Although one large series from the 1980's documented the safety of CEA during general anesthesia without the use of shunts or advanced monitoring modalities such as EEG and CSP, this practice has not been widely accepted [15]. For the selective use of shunting during CEA, intraoperative monitoring such as EEG, CSP, jugular venous oxygen saturation, and TCD are often recommended, in spite of the fact that these monitors are not perfectly reliable indicators of the patient's neurological state [9]. A previous report prospectively correlated neurological state of the awake patient with CSP and EEG and found that neither monitoring technique identified all the patients who developed clinical neurological deficit [16]. Some patients with either EEG changes or low CSP did not develop any neurological deficit. Since both sensitivity and specificity are less than ideal with these monitoring techniques, utilization of shunts during CEA are more prone to errors such as overuse or underuse.

The recent multi-center GALA (general anesthesia vs. local anesthesia) trial reported 14% shunt utilization for patients with local anesthesia and 43% if general anesthesia was used [17]. In the present series, shunt utilization was very low and comparable to another large series that showed that monitoring the neurological state of the awake patient can decrease the need for shunting from 3.8% to 9.7% [18]. In our series, the need for a shunt was further reduced to 2%, probably because the safety of carotid clamping was shown during regional anesthesia in most patients, even when general anesthesia was eventually instituted. This decrease in the use of shunts can minimize potential shunt complications, operating time, and technical problems, and also decrease the associated costs. Utilization of shunts is likely to increase patient morbidity and decrease the cost-effectiveness of the surgery. This situation is particularly important in a developing country setting such as ours. Because clinical neurological monitoring is the most reliable method of assessing cerebral function during surgery, an awake patient may be the ideal for CEA [9].

There has been considerable debate as to whether general or regional anesthesia is preferable for CEA [19]. General anesthesia has its own obvious attendant risks. Hemodynamic instability necessitating the use of vasoactive drugs is a major disadvantage of general anesthesia [20]. There have been conflicting reports regarding the increased incidence of postoperative ICU admissions, increased hospital stay, and costs when general and regional anesthesia are compared [21,22]. However, more evidence favors regional anesthesia with respect to perioperative outcome and costs.

Although the recent GALA trial reported no statistically significant differences in perioperative adverse outcomes between general and regional anesthesia for this surgery, the finding may be due to lack of statistical power [23]. The greatest advantage of regional anesthesia for CEA is the ability to clinically monitor the neurological status of the patient. Reports have clearly shown that regional anesthesia lowers the risk of stroke and death in the perioperative period [24]. Thus, the lower incidence of morbidity and zero mortality in our case series may be attributable to the use of the regional anesthetic technique. The effects of the brief period (three min) of carotid artery clamping and clinical testing for neurological impairment had been suggested as early as the 1970's [25]. We suggest that these actions are the cornerstone of the better perioperative outcome noted in the present series.

However, an important caveat here is that even if the patient may be normal during the three-minute clamping period, ischemia may occur at a later stage. Hence, the patient should be carefully and continuously monitored to avert the possibility of hypotension. In fact, two of our cases developed hemiparesis towards the end of the procedure; however, they were resolved immediately on declamping without the need for shunting.

Although the value of "deep cervical plexus block" for CEA was disputed by a recent study [26], it was our preferred technique 25 years ago. Recently – and not in the time period covered by this study – we adopted "superficial cervical plexus" block in some patients. However, in our experience there is an increased need for supplementation of local anesthetic infiltration, especially during dissection of the distal portion of the ICA.

Other disadvantages of regional anesthesia may include intravascular injection of the local anesthetic, inadequate anesthesia, and compromised patient anxiety. Furthermore, some reports have found a higher frequency of perioperative myocardial ischemia when CEA was done with regional anesthesia [27]. None of our patients developed myocardial ischemia during the perioperative period. The results of our case series are comparable to those from private institutions in India and the U.S. [11,28]. Our conversion rate to general anesthesia, however, was a little higher (6%) than that of an earlier report (1.1%) [18], but well within the range of the overall literature (0.1% to 11.6%) [19].

In conclusion, CEA with regional anesthesia is associated with a low rate of morbidity and mortality, and it may be recommended as the preferred method of anesthesia for this surgery in the setting of a developing country with limited resources. If conversion to general anesthesia is needed during the procedure, whenever feasible carotid clamping for three minutes should be done in the awake patient to clinically assess neurological function.

References

[1] Halm EA, Tuhrim S, Wang JJ, Rojas M, Hannan EL, Chassin MR. Has evidence changed practice? Appropriateness of carotid endarterectomy after the clinical trials. Neurology 2007;68:187-94.

[2] MRC European Carotid Surgery Trial: interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. European Carotid Surgery Trialists' Collaborative Group. Lancet 1991;337(8752):1235-43.

[3] Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med 1991; 325:445-53.

[4] Moritz S, Kasprzak P, Arlt M, Taeger K, Metz C. Accuracy of cerebral monitoring in detecting cerebral ischemia during carotid endarterectomy: a comparison of transcranial Doppler sonography, near-infrared spectroscopy, stump pressure, and somatosensory evoked potentials. Anesthesiology 2007;107:563-9.

[5] McCarthy WJ, Park AE, Koushanpour E, Pearce WH, Yao JS. Carotid endarterectomy. Lessons from intraoperative monitoring–a decade of experience. Ann Surg 1996;224:297-305.

[6] Lacroix H, Beyens G, Van Hemelrijck J, Nevelsteen A, Verhaeghe R, Suy R. Is transcranial Doppler useful in the detection of internal carotid artery cross-clamp intolerance? Cardiovasc Surg 1999;7:203-7.
[7] Papavasiliou AK, Magnadottir HB, Gonda T, Franz D, Harbaugh RE. Clinical outcomes after carotid endarterectomy: comparison of the use of regional and general anesthetics. J Neurosurg 2000;92:291-6.
[8] Aleksic M, Rueger MA, Sobesky J, Heckenkamp J, Brunkwall J. Immediate CEA for symptomatic carotid disease preferably performed under local anaesthesia is safe. Vasa 2007;36:185-90.
[9] Hans SS, Jareunpoon O. Prospective evaluation of electroencephalography, carotid artery stump pressure, and neurologic changes during 314 consecutive carotid endarterectomies performed in awake patients. J Vasc Surg 2007;45:511-5.
[10] Donnan GA, Fisher M, Macleod M, Davis SM. Stroke. Lancet 2008; 371(9624):1612-23.
[11] Singh SM, Rajmohan T, Juneja R, Mehta Y, Trehan N. Carotid endarterectomy under regional analgesia: a retrospective study (1988-1999). Ann Card Anaesth 2001;4:7-12.
[12] Alam SA, Haque MN, Quraishi MF, et al. Carotid eversion endarterectomy: prospects in a developing country. Saudi Med J 2003;24:909-11.
[13] Vigo J, Brau RH. Carotid endarterectomy in Puerto Rico. Bol Asoc Med P R 1992;84:128-31.
[14] Halsey JH Jr. Risks and benefits of shunting in carotid endarterectomy. The International Transcranial Doppler Collaborators. Stroke 1992;23: 1583-7.
[15] Whitney DG, Kahn EM, Estes JW, Jones CE. Carotid artery surgery without a temporary indwelling shunt: 1,917 consecutive procedures. Arch Surg 1980;115:1393-9.
[16] Evans WE, Hayes JP, Waltke EA, Vermilion BD. Optimal cerebral monitoring during carotid endarterectomy: neurologic response under local anaesthesia. J Vasc Surg 1985;2:775-7.
[17] GALA Trial Collaborative Group, Lewis SC, Warlow CP, Bodenham AR, et al. General anaesthesia versus local anaesthesia for carotid surgery (GALA): a multicentre, randomised controlled trial. Lancet 2008;372(9656):2132-42.
[18] Shah DM, Darling RC III, Chang BB, Bock DE, Paty PS, Leather RP. Carotid endarterectomy in awake patients: its safety, acceptability, and outcome. J Vasc Surg 1994;19:1015-9.
[19] Guay J. Regional or general anesthesia for carotid endarterectomy? Evidence from published prospective and retrospective studies. J Cardiothorac Vasc Anesth 2007;21:127-32.
[20] Mutch WA, White IW, Donen N, et al. Haemodynamic instability and myocardial ischaemia during carotid endarterectomy: a comparison of propofol and isoflurane. Can J Anaesth 1995;42:577-87.
[21] Angevine PD, Choudhri TF, Huang J, et al. Significant reductions in length of stay after carotid endarterectomy can be safely accomplished without modifying either anesthetic technique or postoperative ICU monitoring. Stroke 1999;30:2341-6.
[22] Meitzner MC, Skurnowicz JA, Mitchell A. A literature review on anesthetic practice for carotid endarterectomy surgery based on cost, hemodynamic stability, and neurologic status. AANA J 2007;75: 193-7.
[23] Guay J. The GALA trial: answers it gives, answers it does not. Lancet 2008;372(9656):2092-3.
[24] Halm EA, Hannan EL, Rojas M, et al. Clinical and operative predictors of outcomes of carotid endarterectomy. J Vasc Surg 2005;42:420-8.
[25] Moore WS, Yee JM, Hall AD. Collateral cerebral blood pressure. An index of tolerance to temporary carotid occlusion. Arch Surg 1973; 106:521-3.
[26] Guay J. Regional anesthesia for carotid surgery. Curr Opin Anaesthesiol 2008;21:638-44.
[27] Landesberg G, Erel J, Anner H, et al. Perioperative myocardial ischemia in carotid endarterectomy under cervical plexus block and prophylactic nitroglycerin infusion. J Cardiothorac Vasc Anesth 1993; 7:259-65.
[28] Donato AT, Hill SL. Carotid arterial surgery using local anesthesia: a private practice retrospective study. Am Surg 1992;58:446-50.