Myocardial infarction following regional anaesthesia for carotid endarterectomy

Donald S. Prough MD, Phillip E. Scuderi MD,
Edward Stullken MD, Courtland H. Davis, JR. MD

From 1969 through 1982, 185 carotid endarterectomies were performed under regional anaesthesia on 153 patients. Of these patients, 38 (25 per cent) had suffered a previous myocardial infarction, 63 (41 per cent) had documented coronary artery disease, and 115 (75 per cent) had hypertension. Anaesthesia was provided by a superficial cervical plexus block. Monitoring consisted of measurement of direct arterial pressure and continuous display of the electrocardiogram. Oxygen was administered by nasal cannula throughout the procedure. Mean arterial pressure was elevated when necessary by infusion of phenylephrine. No patient in this study suffered an acute myocardial infarction. The only cardiac complications consisted of eight episodes of non-life-threatening dysrhythmias. We conclude that regional anaesthesia for carotid endarterectomy is associated with a low risk of perioperative myocardial infarction.

Key words

SURGERY: cardiovascular, carotid endarterectomy;
ANAESTHETICS, LOCAL: lidocaine, mepivacaine,
prilocaine, bupivacaine; **HEART:** myocardial
infarction.

Myocardial infarction (MI) is a major cause of morbidity and mortality following carotid endarterectomy.¹⁻³ Many factors may contribute to the risk of perioperative infarction, including advanced age, generalized atherosclerosis, haemodynamic instability, and the need (in some patients) for pharmacologic elevation of blood pressure in the intraoperative and postoperative periods.⁴ The incidence of MI in recent series has ranged from zero⁵ to 18.2 per cent,¹ the latter percentage being reported for a high-risk group of patients with symptomatic coronary artery disease.

It is unclear to what extent choice of anaesthesia may influence the incidence of MI after carotid endarterectomy. Hypotension secondary to general anaesthesia may precipitate ischaemia or infarction in patients with symptomatic or occult coronary artery disease.^{6,7} Similarly, hypertension and tachycardia in response to endotracheal intubation may increase myocardial oxygen demand and thereby produce ischaemia.⁸ Regional anaesthesia, on the other hand, may produce anxiety and therefore be physiologically stressful for patients with coronary artery disease. Regardless of the type of anaesthetic used, it is a common practice in many institutions to induce hypertension pharmacologically during carotid cross-clamping. This practice, in itself, may increase the risk of perioperative infarction.⁴

It is unknown whether the choice of anaesthesia affects perioperative morbidity and mortality. At our institution, regional anaesthesia is the procedure of choice for carotid endarterectomy. Only in patients who develop symptoms of neurologic deficit during cross-clamping, despite pharmacologically induced hypertension, do we employ general anaesthesia and an internal carotid bypass shunt. This paper reviews our experience with regional anaesthesia for carotid endarterectomy in terms of the risk of perioperative cardiovascular complications.

From the Department of Anesthesia and the Section on Neurosurgery, Department of Surgery, Bowman Gray School of Medicine of Wake Forest University, Winston-Salem, North Carolina.

Address correspondence to: Donald S. Prough MD, Department of Anesthesia, Bowman Gray School of Medicine, 300 S. Hawthorne Road, Winston-Salem, North Carolina 27103.

Methods

We retrospectively reviewed 185 carotid endarterectomies performed on 153 patients by one of the authors (C.D.) under regional anaesthesia in the years from January 1969 to February 1982. Each chart was reviewed to determine age and sex of the patient, ASA physical status classification, and history of preoperative cardiac disease. Significant factors looked for in the cardiac history included hypertension, coronary artery disease, congestive heart failure, valvular disease, dysrhythmias, and previous MI (based upon history, electrocardiogram, or cardiac enzymes). Evidence of pulmonary disease was recorded. The intraoperative period was reviewed to determine the type of anaesthetic, duration of anaesthesia, evidence of inadequate analgesia, occurrence of neurologic symptoms with carotid cross-clamping, and need for intraoperative vasopressors. The postoperative (from the completion of operation until discharge) period was evaluated for occurrence of MI, incidence of hypertension, need for vasopressors, duration of stay in the intensive care unit, and occurrence of congestive heart failure, dysrhythmias, and death.

Anaesthetic management was similar throughout the series. Patients received intramuscular pentobarbital, 1.0 to 1.5 mg·kg⁻¹, or oral diazepam, 0.1 to 0.15 mg·kg⁻¹. Routinely, monitoring included electrocardiogram and blood pressure. (Early in the series, a lead II electrocardiogram and a blood pressure cuff were used; later in the series, all patients had direct arterial pressure monitoring, and, in the majority, both lead II and lead V₅ were observed.) All patients received a superficial cervical plexus block. (Lidocaine, mepivacaine or prilocaine were used until bupivacaine became available for clinical use; bupivacaine was used routinely thereafter.) All patients received oxygen by nasal cannula during the procedure. Small doses of intravenous diazepam and narcotics were titrated as necessary. A vasoconstrictor, usually phenylephrine, was used in the majority of patients to maintain mean arterial pressure 10–20 per cent above the patient's usual level during the period of carotid cross-clamping. If a vasoconstrictor was not used prophylactically, it was given if neurologic symptoms developed during cross-clamping. If symptoms persisted, the procedure was performed under general anaesthesia using an internal carotid shunt. Electrocardiograms and myocardial enzyme values were obtained during the postoperative period if

TABLE 1 Duration of anaesthesia

Duration (hrs.)	Number of patients	% of patients
0–1	15	8.1
1–2	5	2.7
2–3	133	71.9
3–4	32	17.3

chest pain, new dysrhythmias, or hypotension occurred.

Results

Thirty-eight patients (25 per cent) had suffered a previous MI based upon clinical history, electrocardiogram, or enzyme evidence. An equivocal history of MI was present in ten other patients (6.6 per cent). Classic angina was seen in 63 patients (41 per cent), some of whom also had a positive exercise stress test or arteriographically proven coronary artery disease, while 20 other patients (13 per cent) had equivocal evidence of coronary artery disease. Thirty-eight patients (25 per cent) had other cardiac disease, including 29 (19 per cent) with a history of cardiac dysrhythmias, nine (six per cent) with a history of heart failure and nine (six per cent) with a history of valvular heart disease. One hundred fifteen patients (75 per cent) had previous hypertension based upon history or upon a systolic pressure greater than 160 mmHg or a diastolic pressure greater than 100 mmHg on admission to the hospital. Thirty-two patients (21 per cent) had preexisting chronic obstructive pulmonary disease.

Six patients received a deep cervical plexus block in addition to the superficial block. Over the time period studied, general anaesthesia was employed due to persistent neurologic symptoms in 30 patients. No procedure required rescheduling because of failure of regional anaesthesia or poor patient compliance. Duration of anaesthesia is shown in Table 1.

Postoperatively, 150 patients (98 per cent) spent three or fewer days in the intensive care unit. One hundred and seven were returned to a surgical floor on the first postoperative day. Ninety-eight patients were given a vasoconstrictor in the intensive care unit in order to maintain mean arterial pressure at no more than 20 per cent below preoperative values. In 96 patients, phenylephrine was employed in a dose of 0.1 to 0.5 µg·kg⁻¹·min⁻¹. Pulmonary artery

TABLE II Preoperative status: carotid endarterectomy

Series	No. of pts.	Ave. age	% Neurologically asymptomatic	% Preoperative hypertension	% Previous MI	% Heart disease
<i>General anaesthesia</i>						
Asiddao <i>et al.</i> ⁵	166	63	8	60	7*	57
Lees, Hertz ²	335	60	33	69	—	—
Allen, Preziosi ¹¹	131	—	4	58	24	41
Ennix <i>et al.</i> ¹	1238	64	—	56	24	—
Geevarghese, Patel ¹⁰	77	61	27	34	21	—
	1947	62†	18†	55†	19†	49†
<i>Regional anaesthesia</i>						
Prough <i>et al.</i>	153	63	15	75	24	49
Pietzman <i>et al.</i> ¹⁴	314	62	11	—	—	—
Riles <i>et al.</i> ⁴	491	—	—	51	—	41
Rich, Hobson ¹²	232	—	20	—	—	—
	1190	63†	15†	63†	24†	45†

*Personal communication (Judith Donegan MD).

†Calculated for only those series reporting occurrence.

catheterization or central venous pressure monitoring was not done in any patient in this series. Despite the routine use of vasoconstrictors, no evidence of hypoperfusion, such as oliguria or metabolic acidosis, was noted. Only ten per cent of patients had postoperative hypertension.

No patient in this series suffered a perioperative MI. Eight patients (five per cent) had postoperative cardiac complications, all of which were haemodynamically insignificant dysrhythmias: ventricular premature contractions ($n = 3$), which were treated with lidocaine, and sinus bradycardia ($n = 5$), which was treated with atropine. None of the patients with dysrhythmias had electrocardiographic evidence of a new MI. No patient developed congestive heart failure. One patient died postoperatively of a massive stroke.

Discussion

No documented MIs occurred in these 153 patients undergoing 185 carotid endarterectomies under regional anaesthesia. Three major questions must be answered to place this information in perspective. First, is there anything about our population of patients that might make MI less likely? Second, were clinically silent MIs missed in our patients? Third, is there evidence that regional anaesthesia is associated with no more cardiac complications than general anaesthesia for carotid endarterectomy?

Comparison of the preoperative status in our

series of patients with that in other series^{1-5,9-14} is shown in Table II. Unfortunately, the majority of the series reviewed lack some part of the data necessary to make a thorough comparison. The mean age of our patients, 63 years, falls within the range reported for other series (59 to 64 years).^{1,2,5,10,13,14} One hundred thirty patients (85 per cent) in this series were operated on for symptomatic carotid occlusive disease. Of the endarterectomies in the asymptomatic group, most were performed as second procedures in patients who previously had had a surgical procedure for contralateral, symptomatic lesions. Our series of patients, like other series, had a high incidence of preoperative hypertension. Thirty-eight patients (25 per cent) had a previous MI, an incidence close to those of 20.8 per cent,¹⁰ 24 per cent,¹¹ and 23.7 per cent¹ reported in the comparison series. In only one other series¹ was there mention of preoperative, overt coronary artery disease (39 per cent). That incidence is very similar to the incidence of 40 per cent in our series. The total incidence of cardiac disease in our series is also similar to that reported in other series.^{4,5,9,11}

It appears, then, that the cardiovascular status of patients in our series was similar to that of patients in other series. We cannot exclude a difference in the severity of illness of patients referred to our institution for operation. It is probable, for example, that the series of patients reported by Ennix *et al.*¹

had more severe coronary artery disease since many had their carotid artery disease diagnosed during evaluation for myocardial revascularization. We can, however, state with certainty that we did not select lower-risk patients for regional anaesthesia. Superficial cervical plexus block is our technique of choice for *all* carotid endarterectomies, regardless of the severity of intercurrent illness. This reflects our bias that the neurologic examination of an awake patient is an inexpensive, effective form of neurophysiologic monitoring.

There is the possibility that clinically silent MIs occurred in some of our patients. Steen *et al.*⁷ reported that six of 28 patients experienced no chest pain with perioperative reinfarction while Tarhan *et al.*¹⁵ verified the occurrence of pain in only 11 of 28 patients with reinfarction. In the latter series, nine patients suffered cardiac arrest without prior symptoms, and the authors suggested that the frequency of asymptomatic infarction might be explained by residual anaesthetic or analgesic drugs.¹⁵ Our group of patients received minimal systemic medications, and most required no postoperative analgesic drugs. They did not have a electrocardiogram or myocardial enzyme measurement performed postoperatively as a routine procedure. However, the high mortality of postoperative infarction, ranging from 35 per cent¹⁶ to 69 per cent¹⁵ in recent series, makes it unlikely that many silent MIs could have occurred without there being a substantial increase in the number of postoperative deaths.

The question remains whether regional anaesthesia might be as safe as general anaesthesia for carotid endarterectomy. Backer *et al.*¹⁷ have shown in ophthalmic surgical procedures in elderly patients, many with previous MIs and symptomatic coronary artery disease, that local anaesthesia is associated with a very low incidence of perioperative MI. Our results with regional anaesthesia for carotid endarterectomy show a similarly low incidence of cardiovascular morbidity. Three recent series of carotid endarterectomies performed under regional anaesthesia suggest that such good results might be routinely achieved¹²⁻¹⁴ (Table III). In only one report of carotid endarterectomies for which regional anaesthesia was used are a substantially higher morbidity and mortality reported. In that series of 491 patients,⁴ 11 suffered a nonfatal MI and five a fatal MI, for a combined incidence of 3.3 per cent. However, the authors were able to

TABLE III Myocardial infarction after carotid endarterectomy

Series	No. of pts.	% Fatal MI	% Nonfatal MI
<i>General anaesthesia</i>			
Asiddao <i>et al.</i> ⁵	166	0	0
Lees, Hertz ²	335	1.5	—
Allen, Preziosi ¹¹	131	0.7	0.7
Ennix <i>et al.</i> ¹	1238	1.1*	0.8†
Geervarghese, Patel ¹⁰	77	—	2.0
Sundt <i>et al.</i> ³	1145	0.7	0.35
	3092‡	0.8‡	0.77‡
<i>Regional anaesthesia</i>			
Prough <i>et al.</i>	153	0	0
Peitzman <i>et al.</i> ¹⁴	314	0	0.8
Riles <i>et al.</i> ⁴	491	1.0§	1.8¶
Rich, Hobson ¹²	232	—	0.5
	1190	0.33‡	0.78‡

*12.9% incidence in patients with symptomatic coronary artery disease.

†No nonfatal MIs in patients with symptomatic coronary artery disease.

‡Average of those studies in which data were complete.

§Patients with pre-existing heart disease — 1.8% incidence.

¶Patients with pre-existing heart disease — 3.2% incidence.

relate that high incidence of MI to the use of metaraminol in the postoperative period for support of blood pressure. Since metaraminol has potent myocardial stimulant properties, it may be more likely than phenylephrine (the vasoconstrictor employed in our series) to produce myocardial ischaemia.

The incidence of MI in most reported series of carotid endarterectomies performed under general anaesthesia (Table III) is substantially higher than that we observed. However, three of the most recent series, reported by Sundt,³ Asiddao,⁵ and Allen¹¹ and their colleagues, had incidences of 1 per cent, 0 per cent, and 1.4 per cent, respectively. Therefore, it is possible that the minimal cardiovascular morbidity observed in our retrospective study is attainable with any type of anaesthesia as long as currently accepted techniques of monitoring, surgery, and postoperative care are used.

In summary, on the basis of this series of 153 patients undergoing carotid endarterectomy with regional anaesthesia, we feel that the use of regional anaesthesia does not increase cardiovascular risk in such patients. Despite the theoretical possibility of increased myocardial oxygen demand due to the

stress of undergoing a surgical procedure while awake, the number and severity of perioperative cardiac complications in these 153 patients were no greater than have been reported when general anaesthesia is employed.

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Résumé

De 1969 à 1982, 185 endartérectomies de la carotide ont été faites sous anesthésie régionale chez 153 patients. De ces patients, 38 (25 pour cent) avaient déjà eu un infarctus du myocarde, 63 (41 pour cent) avaient une maladie coronarienne documentée et 115 (75 pour cent) souffraient d'hypertension. On pratiquait chez ces patients un bloc du plexus cervical superficiel. On mesurait de façon directe la pression artérielle et on avait un enregistrement continu de l'électrocardiogramme. On administrait de l'oxygène par canule nasale pendant toute la procédure. La pression artérielle moyenne était augmentée, si cela était nécessaire, par l'infusion de phényléphrine. Aucun patient pendant cette étude n'a subi un infarctus du myocarde. Les seules complications cardiaques ont été 8 épisodes de dysrythmies non menaçantes. Nous concluons que l'anesthésie régionale pour l'endartérectomie de la carotide est associée à un faible risque d'infarctus péri-opératoire.