Indications for intensive care unit care after carotid endarterectomy

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Objectives: To describe the complications of carotid endarterectomy and the interventions performed in the intensive care unit (ICU) after carotid endarterectomy. To identify preoperative and recovery room (RR) risk markers for these complications and interventions.

Design: A retrospective case study.

Setting: The ICU of a university hospital.

Patients: One hundred and one patients who required carotid endarterectomy over a 15-month period.

Intervention: Carotid endarterectomy (bilateral procedures in 11 patients).

Outcome Measures: Demographic data including Goldman's cardiac risk index and the therapeutic intervention scoring system (TISS) score to measure the risk of complications.

Results: Most of interventions conducted in the RR and ICU were to control high blood pressure. In the RR, three patients experienced a neurologic event, one patient was reintubated for vocal cord paralysis and one had electrocardiographic abnormalities. Overall, 5 of the 101 patients had neurologic complications and 2 suffered a myocardial infarction. Two patients died, one as a result of a massive stroke and the other of myocardial infarction with cardiogenic shock. The mean (and standard deviation) TISS score in the ICU was 12.6 (3.8). Analysis of all events in the RR was not predictive of events in the ICU. However, the absence of major complications in the RR had a negative predictive value of 97%.

Conclusions: The decision to admit patients to the ICU after carotid endarterectomy should be based on major complications occurring in the RR. A low TISS score and low incidence of complications does not warrant routine admission.

Objectifs : Décrire les complications de l'endartérectomie de la carotide et les interventions exécutées au service des soins intensifs après une telle intervention. Identifier les marqueurs de risque avant l'intervention et à la salle de réveil dans le cas de ces complications et de ces interventions.

Conception : Étude de cas rétrospective.

Contexte : Service des soins intensifs d'un hôpital universitaire.

Patients : Cent un patients qui ont eu besoin d'une endartérectomie de la carotide sur une période de 15 mois.

Intervention : Endartérectomie de la carotide (interventions bilatérales chez 11 patients).

Mesures des résultats : Données démographiques, y compris l'indice de risque cardiaque de Goldman et le résultat selon le système d'évaluation des interventions thérapeutiques (SEIT) pour mesurer le risque de complications.

Résultats : La plupart des interventions effectuées à la salle de réveil et aux soins intensifs visaient à réduire une hypertension artérielle. À la salle de réveil, trois patients ont été victimes d'un accident neurologique, un patient a été intubé de nouveau à cause d'une paralysie des cordes vocales et un autre a présenté des anomalies électrocardiographiques. Au total, 5 des 101 patients ont eu des complications neurologiques et 2 ont subi un infarctus du myocarde. Deux patients sont morts, un à la suite d'une attaque massive et l'autre, d'un infarctus du myocarde avec choc cardiogénique. Le résultat moyen (et l'écart type)

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selon le SEIT aux soins intensifs a été de 12,6 (3,8). L'analyse de tous les événements survenus à la salle de réveil n'a pu permettre de prédire des événements aux soins intensifs. Cependant, l'absence de complications majeures à la salle de réveil avait une valeur prédictive négative de 97 %.

CONCLUSIONS : La décision d'admettre des patients aux soins intensifs après une endartérectomie de la carotide devrait être fondée sur des complications majeures survenues à la salle de réveil. Un résultat faible selon le SEIT et une incidence faible de complications ne justifient pas l'admission de routine.

Carotid endarterectomy is the most frequently performed peripheral vascular procedure. It is indicated for transient ischemic attacks caused by severe internal carotid artery stenosis. Its role in minor stroke and asymptomatic carotid stenosis is currently being re-evaluated.[1–7] The American Heart Association has recently published a statement from a multidisciplinary consensus conference on the indications for carotid endarterectomy.[8] Meanwhile patients who undergo carotid endarterectomy continue to use intensive care unit (ICU) resources as recommended in major vascular surgery textbooks.[9] Different approaches to the standards of care have recently been proposed to decrease the cost of these procedures.[10]

Several complications may occur in the postoperative period, but their overall incidence remains low. Cervical hematomas are infrequent (1.5%), even though the patients are receiving anticoagulation therapy or antiplatelet agents. They occur after extubation or a Valsalva manoeuvre, implying a role for arterial hypertension or venous distension. They are a potential nidus for infection and may be life-threatening due to airway obstruction.

Lability of the blood pressure is a common problem in the first few hours postoperatively. Severe hypertension may cause a hyperperfusion syndrome with consequent intracerebral hemorrhage. Early postoperative stroke may be the result of emboli during surgery, of intimal flaps, of ischemia during clamping or of thrombosis. A stroke may present later after a lucid interval. In all cases of stroke, the patency of the artery must be evaluated before a decision is made to reoperate.

The death rate from carotid endarterectomy is less than 2%. Most deaths are related to associated coronary artery disease.[9] Abnormalities of the ST segment on continuous electrocardiographic monitoring may lead to early suspicion of myocardial infarction. However, the infarction may be silent and detected on serial electrocardiograms and measurement of cardiac enzyme levels. It may also present with its complications of pulmonary edema or arrhythmias.

Other non-life-threatening complications may occur. Cranial nerve injuries are caused by blunt trauma; their dysfunction may be asymptomatic and detected only with careful evaluation. The recurrent laryngeal nerve may be injured by the retractors pressing on the nerve behind the trachea. Vocal cord dysfunction may also be caused by direct injury to the vagus within the carotid sheath, resulting in hoarseness and ineffective cough. Trauma to the superior laryngeal nerve located posteriorly in the carotid sheath may be caused by a vascular clamp or by dissection. The glossopharyngeal nerve may be injured during surgery for a very high lesion, causing dysphagia, nasopharyngeal reflux and aspiration. Finally, trauma to the hypoglossal nerve may affect the mobility of the tongue.

Because of these possible complications, admission to the ICU for close monitoring of neurologic and vital signs has been recommended for patients who undergo carotid endarterectomy. One of the recognized roles for the ICU is to prevent potentially life-threatening events. However, there have been no studies that evaluate ICU admission to avoid complications associated with carotid endarterectomy.

The goals of this study were to describe carotid endarterectomy complications, to report the interventions performed in the ICU after carotid endarterectomy and to identify preoperative and recovery room (RR) risk markers for complications and interventions occurring in the ICU after carotid endarterectomy. The indications for use of the ICU in these patients are discussed to identify those who may benefit most from ICU care.

PATIENTS AND METHODS

At the Hôtel-Dieu Hospital, all patients who have undergone carotid endarterectomy are routinely admitted to the ICU. We reviewed the charts of 101 such patients admitted over a 15-month period (from Sept. 1, 1989, to Nov. 30, 1990), a period when nursing notes were kept in the hospital archives.

The demographic information collected from the charts included age, sex, indication for surgery, history of hypertension, coronary artery disease, chronic pulmonary disease, renal failure, diabetes and smoking habit.

Abnormal physiologic parameters requiring intervention were examined. Abnormalities were counted if they received attention by a physician and were treated with medication or any other intervention. The indications,

pertinence or results of the interventions were not the objectives of this study. Postoperative care was not standardized. Blood pressure was treated if it was over 160 mm Hg systolic. The drug used most commonly to control blood pressure was nifedipine, given sublingually. Bradycardia was treated only when the patient was symptomatic.

Patients were classified according to Goldman's cardiac risk index,[11] and the therapeutic intervention scoring system (TISS)[12] score was calculated. Goldman's index is a well accepted score of the risk of cardiac complications after surgery. The TISS score is the sum of points assigned to all interventions for monitoring or treatment in the ICU; it allows stratification of patients according to their need for services.

The data were used to describe complications and interventions in the operating room (OR), RR and ICU. They were analysed to correlate RR events with events in the postoperative in-hospital period.

Results

One hundred and twelve carotid endarterectomies were performed on 101 patients; 11 had bilateral carotid endarterectomy done over a 2- to 3-week period. The mean (and standard deviation) age of the study population was 66.6 (7.8) years (range from 41 to 82 years). There were 51 men and 50 women. The indications for surgery were as follows: asymptomatic carotid bruit (38 patients), transient ischemic attacks (63 patients) and stroke (11 patients). Forty-six operations were performed on the right side and 66 on the left. Of the 101 patients, 57 had a history of ischemic heart disease, 51 had diffuse atherosclerosis, 52 were tobacco users; 64 were treated for hypertension and 14 for diabetes; 4 patients had no concurrent medical problem. Seventeen patients had only one risk factor, 35 had two and 45 had three and more associated medical problems.

Before operation, the patients were classified according to Goldman's cardiac risk index: 90 were in group I, 10 in group II and 1 in group III.[11] The mean (and SD) TISS score for the first 24 hours of ICU care was 12.6 (3.8). Most points were allotted for arterial cannulae, hourly monitoring of neurologic and vital signs, electrocardiographic monitoring, 24-hour ingestion and excretion values and oxygen administration. Occasionally, a patient received blood products, vasopressor or antiarrhythmic agents, or an intravenous bolus of potassium.

Minor events

In the operating room

Table I summarizes all events that occurred after carotid endarterectomy according to their site of occurrence. In the OR the most frequent complication was blood pressure lability. Hypotensive episodes were controlled with a bolus of phenylephrine or mephentermine in 68 patients. Nine patients were treated for a hypertensive episode and 24 for bradycardia One patient received 2 units of packed red cells for local bleeding. Injury to a branch of the facial nerve was noted once during surgery.

In the recovery room

Patients spent an average of 3.5 hours in the RR. This time varied according to the readiness of ICU beds. The 34 cases of hypertension were treated most frequently with sublingual nifedipine and occasionally with intravenous nitroglycerin. The problem recurred in the ICU and required treatment in 20 (59%) of these 34 cases (18% of the entire group). Hypotension was treated with fluids and occasionally a bolus of phenylephrine. Bradycardia occurred frequently after carotid surgery but it was usually asymptomatic, and in only five cases was treatment with atropine necessary. ST-T abnormalities were noted on the electrocardiogram in two cases, in one of which these same changes had been noted during surgery. Two patients received a potassium bolus and one was also given xylocaine for ventricular ectopy. Three patients bled from the wound, but only one received protamine sulfate. Asymmetry of the nasolabial folds or anisocoria with no other neurologic deficit were noted in seven cases.

Table I

Complications and Interventions After 112 Carotid Endarterectomies

Complication/intervention	OR, no. (%)	RR, no. (%)	ICU, no. (%)
Hypotension	68 (60.7)	11 (9.8)	5 (4.5)
Hypertension	9 (8.0)	34 (30.4)	40 (35.7)
Bradycardia	24 (21.4)	5 (4.5)	1 (0.8)
ST-T segment changes	3 (2.7)	2 (1.8)	—
Myocardial infarction	—	—	2 (1.8)
Neurologic event	—	3 (2.7)	4 (3.6
Intubation	—	2 (1.8)	—

OR = operating room, RR = recovery room, ICU = intensive care unit

In the ICU

On average, ICU stay was overnight: in 97 cases the patient stayed for 24 hours, in 13 cases for 48 hours and in 2 cases for 72 hours. Medications were required in 40 cases — most frequently sublingual nifedipine for high blood pressure. Again, bradycardia was a common finding but was treated in only one instance.

Fifteen other patients had problems requiring intervention in the ICU. Three received packed red blood cells for hemoglobin levels less than 100 g/L. One patient had difficulty breathing because of laryngeal edema. Seven were dyspneic and were treated according to the diagnosis with oxygen alone, bronchodilators, diuretics or chest physiotherapy. Two patients had chest pains and received sublingual nitroglycerin.

Major events

Table II summarizes the major complications encountered after carotid endarterectomy. Two patients had myocardial infarction. One had electrocardiographic abnormalities in the OR; these changes persisted in the RR evolving to a non-Q-wave myocardial infarction in the ICU. The other patient suffered an anteroseptal myocardial infarction within 24 hours of operation. Both patients were in Goldman's class I, and these complications were unexpected.

Overall, neurologic complications occurred in five patients. Three of the complications were apparent in the RR. One patient had a massive cerebrovascular event. A Doppler study showed no flow so he was immediately returned to the OR to remove clots in the artery. He eventually succumbed to brain death from bihemispheric infarcts, confirmed by computed tomography (CT). One patient had left hemiparesis. A Doppler study showed good vessel patency, and the neurologic deficit resolved in a few hours. Another had left brachiofacial paresis, probably from an embolus during operation. In the ICU, one patient suffered a left hemiparesis with brachiofacial predominance after an episode of orthostatic hypotension. The neurologic deficit resolved over the next 3 days. A CT scan in the ICU showed ischemic lesions in the right and left parietal lobes and the right frontal lobe. The fifth patient suffered severe right hemiplegia with aphasia 48 hours postoperatively after returning to a medical ward; immediate cerebral CT did not show infarction or hemorrhage. He died 2 months later.

Only two patients required intubation in the RR. The patient with massive cerebrovascular stroke was never extubated and required mechanical ventilation. The other was put on a T tube because of stridor and a left vocal cord paralysis after right carotid endarterectomy; he had undergone a left carotid endarterectomy 2 weeks earlier. This patient was extubated within 48 hours.

Mortality

Overall, two patients died within 30 days of surgery: the first after a massive cerebrovascular event that was obvious immediately after the operation; the second had non-Q-wave myocardial infarction preceded by ST-T

Table II

Major Complications After Carotid Endarterectomy

Complication	Risk	Time of onset	Outcome
Neurologic			
Massive bihemispheric infarction	DM, GI, TIA	RR	Brain death
Left hemiparesis	DM, GII, stroke	RR	Complete recovery
Left brachiofacial paresis	GI, TIA	RR	Complete recovery
Left hemiparesis	GII, stroke	ICU	Complete recovery
Right hemiplegia and aphasia	GII, CB	48 h	Died 2 mo later
Cardiac			
Myocardial infarction	DM, GI	OR	Died 12 d later
Myocardial infarction	GI	ICU	Survived
Respiratory			
Stridor, vocal cord paralysis	GIII, TIA	RR	Extubation after 48 h

DM = diabetes mellitus, GI, GII and GIII = Goldman's class I, II amd III, TIA = transient ischemic attack, CB = carotid bruit, OR = operating room, RR = recovery room, ICU = intensive care unit

changes in the OR; after recovery on the ward, she was readmitted to the ICU in cardiogenic shock and died.

Analysis

Of the five patients with major neurologic complications, three were in Goldman's class II (30% of the class II patients) and two in class I. Four of these five patients underwent surgery for transient ischemic attack or stroke (4 of 74 patients, 5.4%) and 2 were diabetics (2 of 14 diabetics, 14.3%). The two patients who died within 30 days of surgery were in Goldman's class I. Therefore, Goldman's classification was not predictive of major cardiac events.

Table III documents the number of interventions and complications in the RR and ICU. The interventions included treatment for blood pressure, arrhythmias, myocardial ischemic events, electrolyte abnormalities and major neurologic complications. Minor cranial nerve injuries were not reported. The examination of events compared with the number of events in the RR had a positive predictive value of 76% and a negative predictive value of 62%.

Table IV illustrates the relationship between major events in the RR and all other major events. These events included cardiac and neurologic complications as well as the need for intubation and mechanical ventilation. The absence of events in the RR had a negative predictive value of 97%.

Discussion

In this series there were only eight major complications: five neurologic events, two myocardial infarctions and one upper airway obstruction from vocal cord paralysis. Five major events occurred in the RR and two in the ICU. One patient had a stroke after discharge from the ICU. After carotid endarterectomy all patients were routinely admitted to the ICU, where they required services accounting for 12.6 (3.8) TISS points.

There was 4.5% immediate morbidity from major neurologic events. However, three patients recovered completely within days, leaving two patients with severe, permanent neurologic deficits. Immediate morbidity from myocardial infarction was 1.8%. Overall, 30 day-mortality was 1.8%.

In many institutions, patients are routinely admitted to the ICU after carotid endarterectomy to prevent adverse events through close monitoring. This practice is the result of a previous investigation,[13] which suggested that patients benefit from early intervention, particularly for blood pressure lability occurring during the first 24 hours after operation.

In our retrospective study, most interventions in the RR and ICU were for labile blood pressure. The seriousness of hypertension after carotid surgery remains controversial. Some[14–16] believe that hypertension is associated with neurologic complications; others[17,18] do not. In the ICU, 35.7% of our patients had a medical intervention for high blood pressure. Half of them had already received medication in the RR for hypertension. In fact, 58.8% of patients treated for this condition in the RR were eventually treated again in the ICU for high blood pressure.

The pertinence of these minor interventions cannot be assessed retrospectively: analysis of Table III suggests that the overall high percentage (76%) of patients who had some intervention in the RR also had some intervention in the ICU. However, from Table IV it can be seen that the negative predictive value of "no major events" in the RR is 97%. Therefore if no major event occurs in the RR it is unlikely to happen later on.

These results are comparable to

Table III

Relationship Between Events in the Recovery Room (RR) and the Intensive Care Unit (ICU)

Interventions/complications in RR	Interventions/complications in ICU		
	Yes	No	Total
Yes	41	13	54
No	22	36	58
Total	63	49	112

Positive predictive value = 76%, negative predictive value = 62%

Table IV

Relationship Between Major Events in the Recovery Room (RR) and All Other Major Events

Major complications in RR	Major complications		
	Yes	No	Total
Yes	5	0	5
No	3	104	107
Total	8	104	112

Positive predictive value = 100%, negative predictive value = 97%

those of a study on the utilization of ICU resources for this type of patient: O'Brien and Ricotta[19] found that only a few patients benefit from specific ICU care. These authors established that admission to the ICU could be decided on the basis of the treatment required in the RR. From their recommendations and supported by our results only 5 of the 112 carotid endarterectomies in this study would have resulted in the patient's admission to the ICU (Table II): three patients with an early neurologic deficit, the patient with persisting electrocardiographic changes and the patient with vocal cord paralysis.

The low TISS score reflected the fact that these patients were admitted to the ICU for monitoring only. The low score was also the result of minor interventions that could have been performed on a regular ward or an intermediate care unit. However, from our data, we could not determine whether these minor interventions had an influence on the low incidence of major complications. Since more that half of them occurred in the RR, the impact of ICU care on major complications must be marginal.

Conclusions

We conclude that routine ICU admission after carotid endarterectomy is not warranted. With low TISS scores, it is reasonable to recommend a lower nurse : patient ratio. A prospective evaluation of a change in practice will eventually be done. ICU admission is recommended only if a major event in the RR justifies it.

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