

ORIGINAL ARTICLES

Early Neurologic Complications Following Coronary Bypass Surgery

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Abstract

Background

Coronary artery bypass surgery is associated with central and peripheral nervous system complications in the period following surgery. Recognising these complications may help in their prevention or early treatment.

Methods

We reviewed medical records of all the patients who underwent coronary artery bypass surgery at our institution over a period of two years. We studied their risk factors, reasons for surgery, operative variables, and post operative neurologic complications.

Results

Of the 587 coronary artery bypass surgeries performed at our centre over a two year period. We found that 2.04% of these patients developed neurologic complication in the two weeks following the surgery. Fifty percent of these patients suffered from cerebrovascular insults and 50% suffered from cognitive decline. No patients in this group developed seizures or peripheral nerve lesions.

Patients with renal failure, carotid stenosis, history of cerebral strokes, and redo coronary bypass surgery were more predisposed to develop neurologic complications after bypass surgery. Furthermore, a longer stay in the coronary care unit and the development of arrhythmias predisposed patients to neurologic complications.

Mortality for patients who developed neurologic complications post bypass surgery ranged between 16.7% and 33.4%.

Conclusions

Around 2% of patients who undergo coronary artery bypass surgery develop neurologic complications in the period directly after the surgery. Patients with previous history of cerebral, coronary, or carotid disease are more predisposed for such complications, as well as patients who spend more time in the intensive units after the surgery.

Introduction

Coronary artery bypass graft surgery (CABG) is among the most frequent surgical procedures performed on the heart. In the United States more than 500,000 bypass myocardial revascularisations are performed each year.¹ Although CABG surgery has a beneficial effect on the heart, this procedure may have adverse events on the central nervous system (CNS).^{2,3,4,5,6} Neurological complications remain a feared and increasing problem in association with cardiac surgery. Stroke, early and late cognitive decline, seizure, and neuropathy have been reported previously following CABG surgery.^{2,4,7,8} Risk factors for neurologic complications following CABG have also been described.^{5,8,9,10,12}

We performed a retrospective study on patients who underwent CABG at the American University of Beirut Medical Centre, in Beirut, Lebanon, in order to identify the prevalence, the risk factors, and the clinical outcomes of early neurological complications following CABG surgery.

Materials and Methods

Patient Selection

We reviewed medical records of 587 patients who underwent CABG surgery using the International Classification of Disease, Adapted (ICDA) codes between 1st January 2000 and 31st December 2001 at the American University of Beirut Medical Centre.

Recorded information included,

- 1) preoperative risk factors such as patient's age, gender, body mass index, presence or absence of hypertension, diabetes mellitus, dyslipidemia, smoking, renal failure, peripheral vascular disease (PVD), carotid stenosis, prior cerebrovascular disease (CVD), prior CABG,
- 2) intraoperative risk factors such as duration of surgery and duration on pump and
- 3) clinical outcomes up to two weeks post surgery such as stay in critical units, mortality, morbidity, arrhythmias.

We included all patients who underwent CABG for coronary artery disease and who developed neurological complications within two weeks.

All the data were taken from notes written by physicians and nurses in the charts.

Twelve patients were excluded because of concomitant cardiac valve surgery or carotid endarterectomy.

Neurological complications were categorised as

- 1) stroke; defined as the occurrence of new localising or focal neurological deficits for more than 24 hours caused by structural injury confirmed by computed tomography scanning or magnetic resonance imaging of the brain. This group included also patients who developed transient ischaemic attacks;
- 2) early cognitive decline characterised by the installation of acute changes in the mental condition such as disorientation, delirium, confusion, agitation, hallucination, unresponsiveness or psychomotor disturbances;
- 3) seizures;
- 4) focal peripheral nerve entrapments.

CABG Procedure

All patients underwent CABG in the internationally acknowledged way. General anaesthesia, prepping, thoracotomy, heparin, total cardiopulmonary bypass (pump and oxygenate filter). The hearts were cooled down to 28°C by infusing cold crystalloid solution to aortic roots. Segments of long saphenous veins were obtained from both lower extremities and anastomosed to the diseased coronary arteries. At the end of the procedure the heart defibrillated spontaneously and upon achieving normothermia came off bypass and regained normal rhythm.

Statistical Analysis

All continuous variables were compared using T-test and non-continuous variables using chi-square test. Significant variables in the bivariate correlation were entered as independent factors in the multivariate analysis with stroke and altered mental status being the dependent variables. These analyses were performed using Statistical Package for the Social Sciences version 10.00.

Results

Twelve of 575 patients (2.04%) had neurological complications. Half (1.02%) of the patients had cerebrovascular insults and half (1.02%) had cognitive decline. These complications occurred during the operation or within two weeks after CABG surgery. No patient developed seizure or peripheral neuropathy. The average age of the patients who developed any neurologic complication (group 1) was 65.4 years and the average age for those who did not develop any neurologic complication (group 2) was 62 years.

Average body mass index was 27.34 kg/m² in group and 28.6 kg/m² in group 2 (Table I).

Preoperative Risk Factors

Both groups had similar risk factors that predispose to atherosclerosis (Table I). However, renal failure, PVD, carotid stenosis, prior CVD and redo CABG were found to be significantly more prevalent in group 1.

Intraoperative Risk Factors

Neither the mean surgery time nor the mean bypass time showed any significant difference in both groups (Table I).

Two-week Clinical Outcomes

The stay period in the critical units, development of arrhythmias, morbidity and mortality demonstrate a significant high prevalence in group 1 (Table I).

Table 1. Preoperative and Intraoperative Risk Factors with Two-Weeks Clinical Outcomes of Patients who Underwent CABG with (Group 1) and without (Group 2) Neurological Complications.

	Group I	Group II	p value
N	12	575	
Preoperative risk factors:			
Male/Female	10/2	476/99	NS
Mean age (±SD)	65.4(8)	62(10)	NS
Mean BMI (±SD)	27.34(6)	28.6(4.2)	NS
Smokers	64%	62%	NS
Diabetes mellitus	50%	34.7%	NS
Hypertension	57%	42.5%	NS
Dyslipidemia	42.8%	53.3%	NS
Mean serum cholesterol (±SD)	217.4(59)	204(52)	NS
Mean serum triglycerides(±SD)	179.1(76)	194(120)	NS
Mean serum LDL (±SD)	131.4(45)	128.7(50)	NS
Mean serum HDL(±SD)	41(6)	42(13)	NS
Anemia	21.4%	8.9%	NS
Renal failure	42.8%	8%	<0.0001
Periperal Vascular Disease	21.4%	2%	<0.0001
Carotid Stenosis	14.2%	2%	0.006
Prior cerebrovascular disease	21.4%	3%	<0.0001
Redo CABG	28.5%	7%	0.003
Intraoperative risk factors:			
Mean Surgery duration(±SD)	247.8(72) min	220.7(44)min	NS
Mean Stay on pump(±SD)	66.4(16) min	55.1(23) min	NS
Two-weeks clinical outcomes			
Average Stay in critical units(±SD)	4.7(5)days	1.2(1) days	<0.0001
Arrhythmias	46%	1.7%	<0.0001
Mortality	33.4%	0.6%	<0.0001
Morbidity	50%	2.6%	<0.0001

N=Number of patients, BMD=body mass index, SD=standard deviation. NS= statistically non-significant.

Thus, the longer the critical illness duration, the higher the risk for neurological adverse events. Group 1 patients had a higher risk for mortality, morbidity and arrhythmias within the two week follow-up.

The multivariate analysis of these independent risk factors in patients who sustained neurologic complications following CABG revealed that PVD, prior CVD, two-weeks morbidity and redo CABG were more correlated with post-operative cerebrovascular accident (CVA), whereas renal failure, and stay in critical units were the major predisposing factors for altered mental status. Patients who developed encephalopathy were at a higher risk of mortality and morbidity (Table II).

Table 2. Multivariate analysis of independent risk factors in patients who developed neurological complications following CABG.

Variable	B-estimates	R ² *	p-value
Stroke:			
PVD	0.123	0.043	<0.0001
Prior CVD	0.101	0.071	<0.0001
2-weeks morbidity	6.373 E-02	0.084	0.013
Prior CABG	4.886E-02	0.093	0.017
Altered mental status:			
2-weeks morbidity	0.107	0.080	0.002
2-weeks mortality	0.165	0.115	0.016
Renal failure	5.317E-02	0.132	0.009
Stay in critical units	7.974E-02	0.142	0.035

*= cumulative value R² in each row shown as additional significant variable are added to the model.

The patients who developed neurologic complications (group 1) were divided as follows:

1. Six patients (50%) developed focal neurological signs: two (16%) had transient ischaemic attacks (one at day two and the other at day nine), and four (33%) sustained cerebral infarction (two intraoperatively and the others at day one and two).

Two patients had marked improvement, one showed minimal improvement within two weeks, and one passed away three days later (Table III). The distribution of the stroke involved the middle cerebral artery in four patients and the posterior circulation in two.

The mortality rate in this group was estimated to be 16.7%.

- Altered mental status occurred in six patients (50%): three developed intensive critical care psychosis that resolved in few days. Two of the other three patients died; one from sustained cardiac arrest and the other from renal failure and sepsis. The last patient went into a persistent vegetative state after cardiac arrest (Table III). The mortality rate in this group was 33.4%.

Age, sex, years of smoking, diabetes mellitus, hypertension, dyslipidaemia, anaemia, duration of surgery, or time on the pump did not differ between patients who developed neurologic sequelae and those who did not.

Table III. Clinical characteristics and outcomes of 12 patients who developed neurological complications post CABG.

	Age and gender	Day post CABG	Neurological complications	Outcomes
Stroke:				
Patient 1	74y, M	Day 9	TIA(right sided weakness, Expressive aphasia)	Complete resolution.
Patient 2	60y, M	Day 0	L.left upper motor and sensory deficit with left BBK sign.	Marked Improvement
Patient 3	56y, M	Day 0	Right hemiparesis, Coma , Right BBK sign	Mortality 3 days later.
Patient 4	69y, M	Day 2	Right sided ataxia, Dysarthria.	Marked Improvement
Patient 5	63y, M	Day 1	Right upper extremity weakness with right BBK sign.	Minimal Improvement
Patient 6	73y, M	Day 2	TIA(right sided weakness Aphasia)	Complete resolution.
Encephalopathy:				
Patient 1	74y, M	Day 2	ICU psychosis for two days.	Good.
Patient 2	69y, M	Day 2	ICU psychosis for one day.	Good.
Patient 3	62 y, M	Day 3	Confusion,agitation (sepsis, acute renal failure)	Mortality 10 days later.
Patient 4	72y, F	Day 1	ICU psychosis for two days.	Good.
Patient 5	44 y, F	Day 0	Confusion, unresponsiveness (cardiogenic shock)	Mortality six hours later.
Patient 6	65y, M	Day 3	Coma (cardiac arrest)	Vegetative state.

M=male,F=female,y=years, TIA=transient ischemic attacks, ICU= intense care unit, BBK=Babinski.

Discussion

This study consists of a retrospective analysis of acute adverse cerebral outcomes following CABG surgery for a follow-up period of two weeks. CABG surgery was associated with the major risk of focal cerebrovascular insult and neuropsychological impairment post-operatively. No association between CABG and peripheral neuropathy or seizures was found in our study. Cerebral injury is a major cause of mortality and morbidity after CABG.

In our study, neurological complications occurred in 2.04% of these patients. Stroke and altered mental status post surgery encountered an equal percentage of prevalence.

Stroke

Stroke occurred in 1.02%, which is close to the previously reported prevalence that ranges between 0.8 and 5.2%.^{4,5,7,12,13,14}

Cerebral embolism is one of the major pathogenic mechanisms in the occurrence of stroke post CABG.^{15,16} The patients developed embolic events. In one, the embolus occurred intraoperatively during the manipulation of a severely calcified aorta after cross clamping and the second developed a focal neurological deficit postoperatively after an episode of atrial fibrillation. In four patients, the aetiology was not ascertained but presumed to be atherothrombotic considering that all of the patients had multiple risk factors for arteriosclerosis.

Cerebral hypoperfusion during bypass surgery predisposes patients to develop ischaemic stroke especially in the context of carotid stenosis.^{17,18} None of our patients sustained an intraoperative hypoperfusion.

PVD is correlated with stroke as reported by some authors.¹² Prior history of CVD and redo CABG were also found to be an independent risk factor for stroke post CABG. Therefore a history of PVD, CVD and redo CABG may provide additional evidence of diffuse arteriosclerosis and indicate a subgroup of bypass patients at risk for perioperative stroke.

Altered Mental Status

The incidence found in our series was 1.02%; it is lower than previously reported incidence.^{4,7,11,14}

We could distinguish two categories of early mental changes.

Intensive critical care psychosis developed in 50% of the patients. These patients had a benign course and a good prognosis. In contrast, the other group developed a hypoxic-metabolic encephalopathy. This complication was secondary to cardiac arrest or multiple organ failure leading to death or a vegetative state. The poor clinical outcomes were consistent with the previously reported results in the literature.³ Altered mental status is a devastating complication of CABG and is a significant cause of morbidity and mortality after the operation. Although, our study has certain limitations in view of being a retrospective study and having a small sample number, certain conclusions could be drawn:

- Stroke and encephalopathy occurred in a similar percentage.
- PVD, prior CVD, redo CABG were identify as independent risk factors for the occurrence of stroke, whereas renal failure and the stay in the intensive care units were correlated with altered mental changes.
- The overall mortality in patients with neurologic complications post CABG was 25%. Patients with hypoxic-metabolic encephalopathy appeared to carry poorer functional outcomes.

Further studies including larger samples are needed in order to understand in depth this complication and to prevent its occurrence. The reduction in the incidence of neurological complications post CABG surgery has major financial implications for health care systems and depends mainly on the improvement in medical and surgical management.

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