Original Article

Concurrent Carotid Endarterectomy and Off-Pump Coronary Artery Bypass Graft Surgery in Bangladesh: A Prospective Cohort Study

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Abstract:

A patient of ischemic heart disease (IHD) with additional carotid artery stenosis (CAS) has been distinguished as a high risk group for both heart and cerebral inconveniences following surgical intervention. We aimed to review the outcome of concurrent carotid endarterectomy (CEA) and off-pump coronary bypass graft (OPCABG)in a patient undergoing surgical revascularization for IHD and CAS at our institute.In the vicinity of 2014 and 2016, fifteen patients experienced OPCABG and CEA associatively in a single Surgeon's Practice. Six (40%) patients had a history of myocardial infarction (MI), four (26.66%) had unstable angina (USAP), and three (20%) had USAP together with MI, though two (13.33%) were asymptomatic. Nine (60%) patients demonstrated no neurological manifestations, three (20%) had transient ischemic assaults (TIAs), two (13.33%) experienced stroke, and 1 (6.66%) experienced both. Majority 7 (46.66%) patients had 75-90% carotid artery stenosis and 6(40%) patients experienced right though 8 (53.33%) experienced left CEA and only 1 (6.66%) had bilateral CEA. Five (33.33%) patients were found left main disease (>50% lesion) and 100% patients have had significant Left Anterior Descending (LAD) lesion in this study. Twelve (80%) patients show significant lesion in Right Coronary Artery (RCA) and ten (66.66%) patients had Obtuse marginal (OM) branch disease. CEA was performed before OPCABG in all cases. There were 15 patients (mean age 62.5±2.8 years; 80% were male), two (13.33%) had a perioperative stroke while one of them had TIAs (6.6%). Mean ICU stay was 36.6±4.5 h and patients were released in 10 days. There was no mortality in the early postoperative period and co-morbidity was less significant (6.6% myocardial ischemia, 13.33% atrial fibrillation, 6.66% TIA, 13.33% Stroke). There was 1 (6.66%) postoperative acute renal failure evidenced by raised serum creatinine level. Two (13.33%) patients showed respiratory complications; only 6.6% of them suffered from wound infection. A combined strategy by means of CEA with OPCABG is safe and savvy in view of the satisfactory consequences of morbidity and mortality rates and also short ICU and hospital stay status.

Key words: Carotid Artery Stenosis (CAS), Coronary Artery Disease (CAD), Off-Pump Coronary Artery Bypass Grafting (OPCABG), Carotid Endarterectomy (CEA).

Introduction:

Atherosclerosis is a systemic disease affecting large and medium-sized arteries in which plaque builds up inside the arteries causing thickening and hardening of arteries. Plaque is composed of cholesterol, fatty substances, cellular waste products, calcium and fibrin. Atherosclerotic plaque may partially or totally occlude the blood's flow through an artery in the heart, brain, pelvis, legs, arms or kidneys that may develop coronary heart disease, carotid artery disease, peripheral artery disease (PAD) and chronic kidney disease[1]. Significant blockade (> 70% stenosis) of coronary and carotid artery requires surgical intervention. The surgical options for coexisting CAD and CAS include Concurrent Carotid Endarterectomy (CEA) and OPCABG or a sequential approach; two stage operation either CEA followed by OPCABG or OPCABG followed by CEA. Sequential or staged approach demonstrated low morbidity and mortality. Combined approach provides lower incidence of MI, stroke and death as well as cost effective using a single anesthesia and hospitalization. The signs and advantages of surgical revascularization of ischemic coronary or carotid artery disease are sufficiently documented[1,2], though the most suitable surgical choice

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for concurrent coronary and carotid illness remains a subject of verbal confrontation. As indicated by other studies, about 8%-14% of coronary artery bypass grafting (CABG) patients have severe carotid artery stenosis[3,4] and 40%-50% of carotid endarterectomy (CEA) patients have coronary vascular disease[5,6]. Unfriendly neurologic occasions happened in 6.1% of elective CABG patients who had carotid artery stenosis correspondingly[7]. In addition, when carotid artery surgery was performed in patients with symptomatic coronary artery disease, contemplates have proposed a rate of postoperative myocardial ischemic tissue of roughly 7%, while its rate was 1% if the CEA was done in asymptomatic patients[8,9]. Subsequent to perceiving that total revascularization can be performed on the beating heart with partial aortic control, the prevalence of utilizing off-pump CABG (OPCABG) expanded in these concurrent coronary and carotid artery disease patients on account of their propensity to be at high hazard for perioperative unfriendly neurologic occasions when contrasted to the customary CABG strategy[10].

However, till date there is no study regarding the outcome of concurrent CEA with OPCABG surgery in Bangladesh and we aimed to review the safety of concurrent OPCABG with CEA for critical coexistent coronary and carotid artery disease. Using this surgical approach for critical coexistent disease may minimize the incidence of perioperative cerebrovascular complications in patients undergoing OPCABG.

Materials and Methods:

We explored the early follow up information of 15 patients with concurrent carotid and coronary artery disease, who experienced concurrent CEA with OPCABG in the vicinity of 2014 and 2016 in a single Surgeon's Practice. Pre-operative, intra-operative, and early postoperative factors were gathered reflectively. Hypertension (n = 15, 100%), smoking (n = 12, 80%), diabetes mellitus (n = 9, 60%) and dyslipidemia (n = 12, 80%) were the major atherosclerotic hazard variables. Six (40%) patients had a heart history of MI, four (26.66%) had unstable angina (USAP) and three (20%) had USAP together with MI, though two (13.33%) were asymptomatic. Nine (60%) patients demonstrated no neurological manifestations, 3 (20%) had transient ischemic assaults (TIAs), 2 (13.33%) experienced stroke, and 1 (6.66%) experienced both. Ipsilateral stenosis was 82.5 ± 5.5% (Table 1); 5 patients had 50%-75%, 7 patients had 75%-90%, and 3 patients had >90% stenotic carotid injuries. There were 5 patients with left main coronary artery disease.

Surgical procedure:

Carotid endarterectomy: Carotid endarterectomy was done under general anesthesia[3]. Incision and proper exposure of the carotid bifurcation area followed by systemic heparinization was done before clamping the carotid artery (heparin 100 IU/kg) to achieve ACT (activated clotting time) of 250-300s. Carotid endarterectomy was performed through neck incision just anterior to the sternocleidomastoid muscle, consequently uncovering the common, internal, and external carotid artery. The carotid artery was opened through a longitudinal incision to the distal part of the common carotid artery, trailed by an endarterectomy with preservation of internal jugular vein, and direct closure of arteriotomy technique was applied. The incision was closed in layers.

The eversion strategy of CEA was performed through the plane between the external layers of media and the adventitia. The atheroma was pulled back and disconnected circumferentially while the external layer of the carotid artery remains intact and everted. The eversion advanced distally and delicate forceps was utilized to totally evacuate the atheromatous plaque. CEA first performed in ICA to secure cerebral circulation; then endarterectomy of the ECA and CCA was accomplished in a similar way. The neck wound was left open until the heparin was turned around by means of protamine after CABG. The injury was closed after CABG and switching the heparin, with or without seepage. The arteriotomy was closed by continuous sutures without utilizing any kind of patches.

Routine duplex scan of carotid vessels to screen the respective carotid artery in both longitudinal and transverse planes was a major aspect of the preoperative assessment in all patients and it was trailed via carotid angiography in cases where significant lesion was shown. Patients experienced CEA either having ≥50% carotid stenosis with one of the side effects like TIAs, ischemic stroke and a past history of cerebral accident or one-sided stenosis of ≥75% with or without complications.

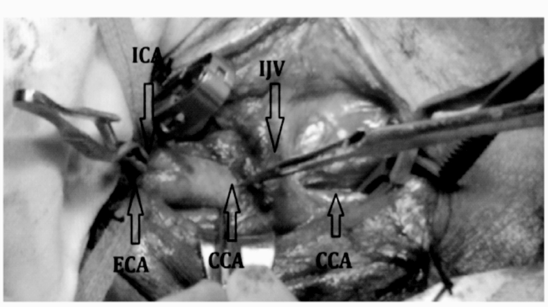

Figure-1: Neck incision showing common carotid artery (CCA), internal carotid artery (ICA), external carotid artery (ECA), and internal jugular vein (IJV).

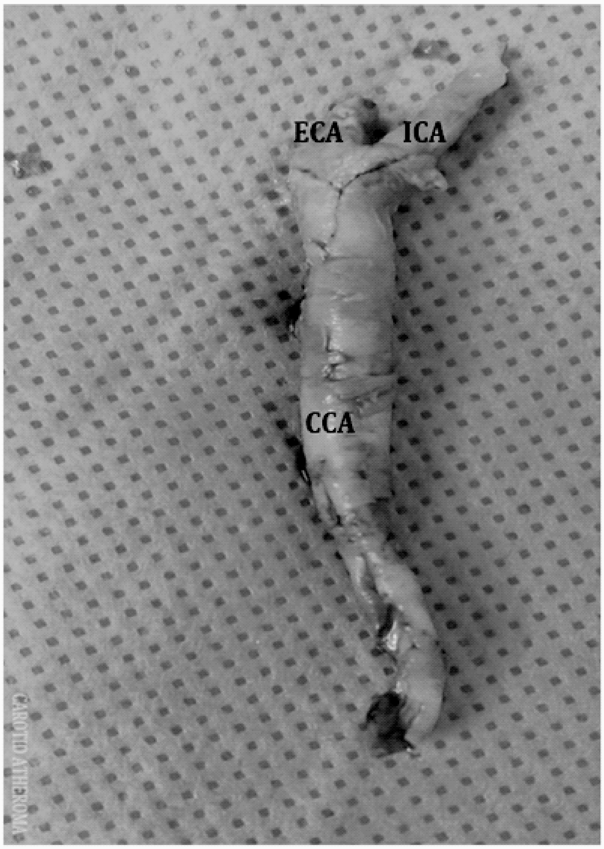

Figure-2: Carotid atheroma involving both internal and external carotid artery (CCA-Common carotid artery, ICA-Internal carotid artery, ECA-External carotid artery).

Technique of OPCABG: Following carotid endarterectomy, a standard median sternotomy was performed. Then pericardiotomy was done and the proximal anastomosis of saphenousvenous grafts was performed with partial aortic clamping. Heart was exposed and stabilized with the aid of a retractor and stabilizer. The targeted coronary artery was stabilized and arteriotomy was performed. An intracoronary shunt was used to allow distal perfusion and distal anastomosis was fashioned. On completion of that operation, protamine was given to restore the preoperative value of the activated clotting time. During surgery, blood pressure was maintained above 70 mm Hg because if pressure is reduced, the patient will be hemodynamically compromised and at an increased risk of stroke. Cardiovascular monitoring included continuous electrocardiogram and routine standard biochemical and hematological profiles and repeat chest radiographs were done. After operation, usually we kept patient in ICU for 36 hours and after that in ward till discharge.

Table-I: Preoperative demographic variable (N=15)

Variables		Number (%)
Age	62.5 ± 2.8 years	
Sex	Male	12 (80%)
	Female	3 (20%)
Risk factors	Hypertension	15 (100%)
	Smoking	12 (80%)
	Dyslipidemia	12 (80%)
	Diabetes mellitus	9 (60%)
Cardiac symptoms	MI	6 (40%)
	USAP	4 (26.66%)
	USAP + MI	3 (20%)
	Asymptomatic	2 (13.33%)
Neurological symptoms	TIA	3 (20%)
	Stroke	2 (13.33%)
	TIA + stroke	1 (6.66%)
	Asymptomatic	9 (60%)
	Ipsilateral stenosis	82.5 ± 5.5%

Table - II shows severity of vascular lesion involving carotid artery and coronary artery. Majority 7 (46.66%) patients have 75-90% carotid artery stenosis. Five (33.33%) patients were found left main disease (>50% lesion) and 100% patients had significant LAD lesion in this study. Twelve (80%) patients show significant lesion in RCA and ten (66.66%) patients had OM disease.

Table-II: Severity of Vascular lesion (N=15)

Severity of Vascular lesion		Number (%)
Carotid artery stenosis	50-75%	5 (33.33%)
	75-90%	7 (46.66%)
	>90%	3 (20%)
Coronary artery disease (>60% lesion)	LM Disease(>50% lesion)	5 (33.33%)
	LAD	15 (100%)
	Obtuse Marginal	10 (66.66%)
	RCA	12 (80%)

Table III shows that 6 patients experienced right (40%), though 8 (53.33%) experienced left and 1 (6.66%) had bilateral CEA. Two (13.33%) had a perioperative stroke while one of them had TIAs (6.6%). One patients (6.66%) experienced single, five (33.33%) double vessel, and 9 (60%) triple or more vessel involvement.

In our study, postoperative outcome was excellent. Mean ICU stay was 36.6±4.5 h and patients were released in 10 days. There was no mortality in the early postoperative period and co-morbidity was less significant (6.6% myocardial ischemia, 13.33% atrial fibrillation, 6.66% TIA, 13.33% Stroke). There was 1

(6.66%) postoperative acute renal failure evidenced by raised serum creatinine levels. Two (13.33%) patients showed respiratory complications; and 6.6% of them developed wound infection (Table IV).

Table III: Operative data (N=15)

Operation		Number (%)
CEA	Right	6 (40%)
	Left	8 (53.33%)
	Bilateral	1 (6.66%)
CABG	Single vessel	1 (6.66%)
	Double vessel	5 (33.33%)
	Triple vessel or more	9 (60%)

Table IV: Postoperative Outcomes (N=15)

Variables		Number (%)
ICU	Intubation time	410 ± 75 min
	ICU stay	36.6 ± 4.5 h
	Mortality	0 (0%)
Cardiac symptoms	MI	1 (6.66%)
	Atrial fibrillation	2 (13.33%)
Neurological symptoms	Stroke	2 (13.33%)
	TIA	1 (6.66%)
Acute renal failure		1 (6.66%)
Respiratory symptoms		2 (13.33%)
Wound infection		1 (6.66%)
Return to theater due to bleeding		0 (0%)

Discussion:

Cardiovascular disease is the leading cause of death worldwide and the importance of concurrent carotid and coronary disease has been recognized since the introduction of aorto-coronary bypass surgery, with the first series of combined CEA-CABG published in 1972[1]. The concurrent CEA-OPCABG procedure is typically performed to reduce the risk of cerebral injury and stroke. CEA is done to improve blood flow to brain and relieve the neurological symptoms of carotid artery stenosis and to prevent cerebral ischemia and infarction and consequent permanent neurological deficits. Patients with IHD are associated with 3-12% incidence of CAS. The presence of CAS increases the risk of stroke after CABG[1,2]. CEA is the gold standard treatment for CAS[3]. Two staged operation approach showed less morbidity and mortality because the surgical stress is divided into two parts with a time gap[4-6]. But the symptoms of CAD or CAS will be present in the interval period and the patients with acute symptoms can't wait for two staged surgeries. But in combined surgery, there is low incidence of stroke, acute MI, mortality, and cost effective with single anesthesia and reduce hospitalization[7]. Surgeons at present prefer CEA with off pump coronary bypass in a single sitting, because of low pressure circulation and high dose of heparin use during on pump CABG. Combined CEA with OPCABG is safe, effective, and with less neurological complication compared to combined (CEA + on pump CABG) and staged approach. For concurrent surgery (CEA + OPCABG) general anesthesia is preferred because of long duration of surgery, better cardio-pulmonary control and neuro-protection. Modern endovascular techniques e.g. stent/percutaneous transluminal angioplasty (PTA) may perform prior to CABG in high-risk patients like moribund condition, high up carotid stenosis, presence of neck wound. But the risks of mortality and morbidity are equivalent to CEA in symptomatic and asymptomatic patients. But the risk of incidence of thrombosis and re-stenosis is little more in patient with stent/PTA[8].

A proceeding with discussion exists about the most suitable surgical choice for patients with coronary artery disease requiring surgery who additionally have noteworthy carotid artery disease. Approaches differ from thoroughly disregarding carotid artery stenosis at the season of myocardial revascularization, to performing organized operations, or directing the double operations with single anesthesia[9]. Neurologic monitoring is an important safety measure for CEA. There are various methods of neurological monitoring like electroencephalography (EEG), somatosensory-evoked potential (SSEP), transcranial Doppler (TCD), ICA stump pressure, regional cerebral O_2 saturation (rSO_2), bispectral index (BIS)[5]. Detection of cerebral hypo-perfusion by any of these methods will guide for immediate placement of intraluminal shunt. BIS can provide more information regarding interactions between cortical and sub cortical neuronal generators and can correlate with clinical measures of hypnosis, sedation, reduced cerebral metabolic rate, and also cerebral hypo-perfusion. The presence of cerebral infarct and hypertension increase the perioperative neurologic risk[9]. But we can't perform neurological monitoring due to our technical limitation. We surmise that when a specialist works on just a single disease at the season of surgery he or she will experience the unfavorable impacts of the other, at peri-operatively as well as postoperatively. Diverse creators have played out the consolidated approach like us as the system of decision in concurrent blood vessel illness to maintain a strategic distance from MI and lessen neurologic deficiencies[7].

In a study of simultaneous surgery in 94 papers, in a total of 7863 procedures, Naylor et al. observed the rate of stroke 4.6%, AMI 3.6%, and death 4.6%. Analysis of results according to publication date (1972-1992 vs. 1993-2002), showed a decrease in death rate (5.2% vs. 4.4%), stroke (6.5% vs. 3.3%), and AMI

(4.3% vs. 3.4%)[10]. Postoperative consequences of our experience were 1 (6.6%) MI, 2 (13.33%) stroke, and 1 (6.6%) TIA cases without any mortality. Fichino et al. also reported their outcomes after combined surgery in thirty patients in Brazil. No perioperative AMI was found; two patients had post-operative TIA (6.6%) and mortality rate was (6.6%) due to stroke. There were 51 patients enduring stroke (6.0%) while 40 of them were dead (4.7%) from 844 patients that experienced a joined strategy. A critical optional end purpose of this paper was MI and 4.6% of the patients indicated MI[11]. Borger et al. also arranged a meta-analysis utilizing the discoveries of 16 studies contrasting consolidated and organized techniques. Despite the fact that the consequences of the arranged methodology of this meta-analysis exhibited noteworthy abatements in the rates of the essential results of these reviews as they were stroke and mortality, there were likewise examines in the paper recommending joined systems to be the best decision in patients with concurrent carotid and coronary artery disease[12].

Meharwal et al. expressed that the benefits of combined CABG and CEA over the organized method were less introduction to anesthesia and cost-adequacy relying upon a shorter time of ventilatory support, and ICU and doctor's facility remain. Mean intubation time was 18 h, emergency unit was 22 h, and time of release was 6.2 days in their review[7], though mean intubation time was around 7 hours, ICU stay was 36.66 hours, and the hospital release time frame was 10 days in our study, exceptionally satisfactory outcomes. Following combined surgery, Mackey et al. also observed that mean duration of hospital stay was 10.3 to 16 days[13].

Mishra et al. analyzed a gathering of 166 patients who experienced a concurrent strategy by OPCABG and CEA in contrast to 192 patients who experienced a joined methodology by conventionalon pump CABG and CEA[14]. Pre-operative, operative and postoperative data of both gatherings were compared and despite the fact that the OPCABG gathering's outcomes were better there were no factually huge contrasts between the gatherings however a portion of the useful impacts of OPCABG in these conceivably high hazard patients for perioperative neurologic antagonistic impacts were obviously experienced. The mix of OPCABG with CEA for patients with existing together carotid and coronary disease keeps away from CPB and shields the patients from stroke by disallowing nonpulsatile extracorporeal dissemination and its unfavorable impacts, for example, low stream marvels and irritation, and goes around the vast majority of the real hazard elements of stroke by means of partial aortic control with a consequence of a lessened danger of atheroembolism emerging from the aorta. The other hotspot for embolism is carotid supply routes and the hazard for carotid embolism is decreased by performing CEA before OPCABG in joined techniques. We also do that; first CEA followed by OPCABG.

In a study, Dylewski et al. shows the occurrence of co-morbidity following combined CEA with CABG which is similar to our findings. They found 12% respiratory complications, 6% acute kidney failure, 5% bleeding complication needs surgical re-intervention, 4% wound infection, 33% arrhythmias in their study population[15].

In our study, significant common carotid artery stenosis with history of co-morbidities like TIA, HTN, DM and multi-vessel coronary artery disease, necessitate combined surgery (CEA + CABG). Because the newer treatment modalities like endovascular stenting or PTCA has the chance of thrombosis, embolization, and stent migration[8]. OPCABG surgery has less neurological morbidity, though on beating heart, the graft anastomosis in multi-vessel disease especially right coronary and circumflex artery may produce severe hemodynamic instability[16,17]. For anesthesia, thiopentone along with fentanyl, norcuronium, isoflurane and lignocaine helped to blunt the hemodynamic response to intubation[18]. We also used thiopentone, fentanyl and norcuronium for anesthesia. Thiopentone has the greatest protective effect against focal ischemia and propofol affords early awakening of patient but may causes hypotension[16,17]. Several studies shows that, use of Isoflurane produces dose related reduction in cerebral metabolic rate of O_2 ($CMRO_2$) with increase cerebral blood flow (CBF), and mannitol reduce intracranial pressure (ICP) and cerebral edema, which is similar to our findings[15,17,19]. Dexamethasone was used for its membrane stabilizing effect in neuroprotection. Dopamine and GTN were used in regulated infusion to maintain stable blood pressure in peri-operative period, which is also coincide to our study[10,17-19].

Conclusion:

Patient with coexisting CAS and CAD, concurrent CEA with OPCABG has been accepted as a standard of management at our institute. Combined approach will result in improve morbidity, single exposure to anesthesia, cost effectiveness and short duration of hospital stay. Maintenance of stable blood pressure (systolic BP 60-70 mm Hg) in the perioperative period is of prime importance and is mandatory for better cardiac and neurological outcome. But the question of management of the second carotid artery stenosis remains unanswered!

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