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OFF-PUMP CABG IN CRITICAL LEFT MAIN CORONARY STENOSIS: A SINGLE CENTRE RETROSPECTIVE STUDY

Cardiology

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ABSTRACT

Objective: This is a retrospective study to find out the effectiveness of off-pump coronary artery bypass grafting (OPCAB) in critical left main disease. **Methods:** A total of 354 patients were included in this study operated for critical left main coronary artery disease with severe triple /double vessel disease and operated by beating heart technique. Results: Early and late mortality in this group was .282% and 1.13% respectively. There was no conversion to on-pump bypass grafting. Mean ICU stay was 1.8 days. Low cardiac output rate was 1.41%, atrial fibrillation rate was 3.39%, both early and late cerebro-vascular accident rate was .282%, transient renal dysfunction occurred in.847%, chronic renal failure in 1.41%. There was no graft occlusion during follow-up. **Conclusion:** OPCAB in critical left main with severe coronary artery disease patients have similar, even better short and long term outcome, and we strongly recommend the use of OPCAB in critical left main disease.

KEYWORDS

Left main coronary artery disease, off-pump coronary artery bypass grafting, coronary artery disease, beating heart CABG.

Critical left main coronary artery (LMCA) disease is always considered as a significant risk and independent prognostic factor for coronary artery disease patients [1]. Coronary artery bypass grafting (CABG) is conferring a significant survival advantage to all these patients of critical coronary artery disease with/without LV dysfunction [2]. Off-pump CABG (OPCAB) was started in 1990 and initially it was restricted to low risk patients i.e. good vessels, normal left ventricular (LV) function, non-LMCA disease and without significant associated lesions. With the improvement of technology and advancement in coronary revascularization instruments, heart stabilizer and knowledge of hemodynamic changes occurring while manipulating the heart, the numbers of OPCAB are increasing steadily and has become widespread worldwide. Still, high risk cases as severe LV dysfunction and critical LMCA disease are posing significant threat to OPCAB because of their inability to tolerate cardiac manipulation and hemodynamic instabilities during beating heart surgery. In this study, we will find out safety and efficacy of OPCAB retrospectively in critical LMCA disease.

Material and method

Patients profile:

This is a single centre, retrospective study conducted at Laxmi Pat Singhania Institute of Cardiology, Kanpur, UP, India. Between the period of January 2015 to March 2020, OPCAB was done in 354 patients of critical LMCA (> 50% stenosis) disease with severe triple (TVD)/double vessel disease (DVD). Patients undergoing concomitant cardiac surgery (i.e. valve repair/replacement, ventricular septal rupture/ aneurysm repair) and patients with previous cardiac surgery were excluded from the study. Patient characteristics were as follows:

Table1: Patient characteristics:

		No. of patients
Age		27-75 years
Sex ratio	Male: Female	196:158
Hypertension		115 (32.48%)
Diabetes Mellitus		65 (18.36%)
Carotid artery disease		8 (2.26%)
Renal dysfunction (not on dialysis)	Creatinine < 3.0 mg/dl	14 (3.95%)
Smoker		96 (27.12%)
Recent Myocardial Infarction (MI)		38 (10.73%)
Preop Intra-aortic Balloon Pump (IABP)		12 (3.39%)
Severe LV dysfunction	LV Ejection Fraction (LVEF) <30%	37 (10.45%)
TVD		225 (63.56%)
DVD		129 (36.44%)
Mild to moderate Mitral Regurgitation		34 (9.60%)
History of previous Percutaneous coronary interventions		29 (8.19%)
Old Cerebrovascular Accident (CVA)		4 (1.13%)
Peripheral vascular disease		3 (.847%)
Obesity		19 (5.37%)
LV aneurysm without thrombus		13 (3.37%)
Chronic obstructive pulmonary disease (COPD)		58 (16.38%)

Surgical technique:

Hemodynamic monitoring, pre-induction preparation and anesthetic induction were according to the standard protocol followed in cardiac surgeries. All the patients were operated by single surgeon.

All operations were done by midline sternotomy. After pericardiotomy, coronary arteries were accessed with gentle cardiac manipulation for grafting decisions. Bilateral pleuro-pericardial release was done to facilitate cardiac manipulation. Left internal mammary artery (LIMA) was harvested first to do LIMA – left anterior descending (LAD) artery grafting as a standard. In those patients, in whom LIMA was not suitable either due to poor pulsation or small caliber or other technical reasons, reverse saphenous vein (RSVG) to LAD was planned. Simultaneously, other conduits (Radial Artery, RSVG) were harvested according to the revascularization decisions. Patients were heparinized to target activated clotting time >380 sec. LIMA to LAD was done as a primary graft without doing much/no

cardiac manipulation. Patients undergoing RSVG to LAD were done by proximal first technique. Proximal anastomoses were done with standard techniques. Y and sequential anastomoses were done for left side arteries only. After completion of distal anastomosis, flow was started immediately. Pericardial stay sutures were used to elevate the apex. Octopus was used without suction to stabilize the heart. Intra coronary shunts were used in every case except those requiring endarterectomy, long arteriotomy or with vulnerable intima. Mister blower was used to keep the field bloodless. Distal anastomoses were done using 7-0/8-0 polypropylene sutures. Radial artery was used for near 100% stenosed target arteries. Complete revascularization was achieved in each patient. Post-procedure, all patients were given clopidogril 75mg+ aspirin 150mg and rosuvastatin 20 mg via nasogastric tube in operative room before shifting to ICU.

RESULTS

Revascularization outcome:

Table 2: Revascularization characteristics:

Conduits		No. of patients
LIMA		348
Radial artery		108
RSVG		330
Only RSVG		8
LIMA +Radial artery +RSVG		79
LIMA + Radial artery		24
LIMA+ RSVG		238
Radial artery + RSVG		5
Endarterectomy		19
LIMA as a free graft		7
Target vessels	LAD	354
	Diagonal	298
	Obtuse marginal	339
	Ramus	48
	RCA	129
	Posterior descending artery (RCA)	81
	Anterior marginal	15

LAD was revascularized by LIMA in all except 8 patients, in whom LIMA was not suitable as a conduit. In these 8 non-LIMA patients, RSVG was preferred as a conduit to LAD. In 7 of LIMA-patients, it was used as a free graft from ascending aorta because of relatively small conduit length and week pulsations despite good caliber. Radial artery was used only to graft vessels that were near total occluded (>95% stenosis). Anterior marginal artery was selected as a target vessel in left dominant cases. Number of distal anastomoses were limited to maximum of 3 for left coronary system and 1 for right coronary system.

Clinical outcome:

Post-operative data were collected from the database and medical records and patient's interview during their follow-up visits.

Table 3: Clinical outcome (Short-term) details

	Numbers
IABP	5 (1.41%) patients
Re-exploration due to bleeding	1 (.282%) patients
Graft revision	0 patients
Atrial fibrillation	12 (3.39%) patients
Arrhythmia requiring defibrillation	0 patients
Mean ventilation time	7.6 hours
Mean ICU stay	1.8 days
Mean blood usage	1.5 unit
Post-operative respiratory complications	5 (1.41%) patients
Renal dysfunction	3 (.847%) patients
CVA	2 (.565%) patients
Peripheral ischemia	0 patients
Low cardiac output	5 (1.41%) patients
Mean hospital stay	8 days
Surgical site complication requiring surgical intervention	2 (.565%) patients
Early Mortality	1 (.282%) patients

There was 1 (.282%) early mortality in this group. This patient was diagnosed as critical LMCA disease with TVD, severe LV dysfunction (LVEF 23%), with recent anterior wall MI and other co-morbidities like HTN, DM, COPD and was kept on IABP preoperatively. He developed low cardiac output postoperatively and was managed by prolonging inotropic support and mechanical ventilation but could not be survived. Low cardiac output developed in 4 (1.13%) more patients but all were managed by inotropic support and IABP implantation. There was no case of graft compromise. Atrial fibrillation occurred in 3.39% patients that were managed by anti-arrhythmic agents. Patients with previous history of CVA remained neurologically stable as preoperatively but two new patients developed seizures postoperatively without any neurological deficit and lesion on computer tomogram and were managed successfully by anticonvulsant therapy. Transient acute renal dysfunction (creatinine level<3 mg%) occurred in 0.847% patients and were managed by renal protection protocols.

Follow-up outcome:

Table 4: Follow up (Long-term) details:

	No. of patients
Angina	5 (1.41%)
MI	0
Repeat angiography	5 (1.41%)
Conduction disturbance	3 (.847%)
Deteriorating LV functions	0
Congestive heart failure	0
Significant Increase or development of mitral regurgitation	1 (.282%)
CVA	1 (.282%)
Chronic renal failure	5 (1.41%)
Mortality	4 (1.13%)

Total follow up period was five years. All patients were followed up as per institutional protocol by repeat electrocardiogram, x-ray and echocardiography done yearly for random wall motion abnormality (RWMA), LVEF and to assess any increase in mitral valve regurgitation. Permanent pacemaker was implanted in 3 (0.847%) patients during follow up due to symptomatic conduction abnormalities. 5 (1.41%) patients developed signs of ischemia but their treadmill tests showed good exercise tolerance without significant ST changes. All 125 patients previously diagnosed with DVD were followed up specially for development of signs of ischemia or new RWMA. Coronary angiogram was done in 5(1.41%) of these patients operated for LMCA and DVD and it was normal for both conduits and RCA. LV functions were preserved in all patients and none developed signs of congestive heart failure. 5 patients (1.41%) developed chronic renal failure. Left hemiparesis occurred in 1 patient (.282%). Late mortality rate was 1.13% (4 patients) and all these deaths occurred due to age related co-morbidities.

DISCUSSION

LMCA disease is an independent predictor of increased mortality and morbidity in coronary artery disease. Approximately 75-100% blood supply of left ventricle is from the LMCA depending upon circulation dominancy and this renders its critical stenosis potentially the most lethal form of coronary disease [3]. The natural history of critical LMCA stenosis has revealed a poor prognosis in non-surgically treated patients; the median survival was 6.6 years in medically treated patients with significant atherosclerotic left main stem disease in the Coronary Artery Surgery study [4]. CABG is considered to be the therapy of choice for this condition [5,6]. The presence of critical LMCA disease was considered a relative contraindication to OPCAB concerning the technical difficulty while operating on a beating heart that could induce cardiac arrhythmias and hemodynamic instability and finally may also result into incomplete revascularization. However, improvements in stabiliser technology, use of intra-coronary shunts, pericardial traction sutures, and positioning the operating table as necessary to maintain hemodynamic stability and greater surgical and anaesthetic experience has minimized the haemodynamic disturbances occurring during the heart manipulation in beating heart surgery. There has been a surge in OPCAB in the last two decades and reports from institutions performing large numbers of revascularization procedures without CPB have confirmed the safety and efficacy of this procedure, with mortality rates of 0%–2.5% [7,8].

In critical LMCA disease, the perfusion of myocardium depends mainly on right coronary system. Occlusion of the RCA before LAD

revascularization may be fatal, as the collateral flow to the left coronary system will also be compromised [9]. It is preferable to revascularize LAD first without lifting the heart out of the pericardial cavity. If LAD is to be perfused by RSVG, then it may be prudent to do it by proximal first technique so that perfusion could be started immediately after completion of the anastomosis. Once perfusion of the LAD has started, the patient tolerates revascularization of the lateral and inferior target coronary arteries in a similar fashion to that of patient with non-LMCA stenosis, even when the heart is lifted perpendicularly [10]. Intracoronary shunts were very important in patients with critical occlusion of the LMCA because the blood supply of the left coronary system wholly depended on the RCA [9].

Statistically significant low rates of postoperative stroke in OPCAB than in on-pump CABG groups were observed in a meta-analysis of nine studies comparing outcomes of on- and off-pump surgery in patients with severe LMCA disease in 4411 patients [11]. Studies consistently showed equivalent or improved outcomes in patients treated with off-pump surgery despite greater preoperative co-morbidity, including a higher incidence of poor left ventricular function in the off-pump groups than in the on-pump groups. Perioperative mortality ranged from 0.0% to 1.9% in the off-pump group compared with 2.2% to 6% with conventional CABG [3].

It is evident that an increasing number of surgeons are realizing the widespread applicability of the OPCAB technique, particularly in patients with multiple comorbidities. LMCA stenosis is no longer a contraindication to OPCAB, and early outcomes of this technique are comparable to those of conventional on-pump CABG. Furthermore, OPCAB is better for preserving renal function in patients with preexisting renal insufficiency [12].

In our study, we didn't find any conversion to on pump CABG and there was 1 (.282%) early mortality. 2 patients (.565%) had convulsions without any neurological deficit. Complete revascularization was achieved in all patients. Post-operatively, low cardiac output was observed in 1.41%. There were no arrhythmias except atrial fibrillation that occurred in 3.39% cases. Acute renal dysfunction occurred in .847%. Long term outcomes were also comparable. Late mortality was 1.13% and all these deaths occurred due to co-morbidities. There was no restenosis or MI. Chronic renal failure developed in 1.41% patients. 1 patient had left hemiparesis and cerebral infarct. In 1 patient, mitral regurgitation severity increased to severe from mild but this patient was in NYHA class 1 on medical management. Our study results are very similar to many previous studies suggesting OPCAB in critical LMCA patients.

CONCLUSION

Left main critical stenosis is considered as most challenging condition among coronary artery diseases. Current clinical guidelines strongly recommend surgical management of LMCA disease. With the advancement of science, technology and clinical experience, critical LMCA disease is no longer considered as a relative contraindication to OPCAB and can be safely and effectively managed by beating heart surgery.

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