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Original Article

Left Main Coronary Artery Disease and Outcome of OPCABG

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Abstract

Background: *Because of concern about the ability to tolerate beating heart grafting, patients with left main coronary artery stenosis (e"50%) have been excluded from off-pump bypass. The objective of the present study was to evaluate the safety and efficacy of off- pump coronary artery surgery in patients with left main coronary artery disease.*

Methods: *From March 2020 to December 2021, a total of 437 patients, 159 of whom had significant LMCA disease, underwent isolated OPCAB surgery under a single Cardiac surgeon at Khulna City Medical College Hospital. We compared the clinical outcomes of 100 patients with LMCA stenosis (LMCA group) with those of 100 propensity score-matched patients without LMCA stenosis (non-LMCA group). We performed off-pump technique in all coronary artery bypass grafting cases. Patients were followed up for any major adverse cardiovascular events up to three years.*

Results: *All CABG were performed by off-pump technique without conversion to on-pump. One patients in the LMCA group (1 of 100; 1%) and one in the non-LMCA group (1 of 100; 1%) died within 30 days after surgery. Follow-up was completed in 98% of the patients. The rates of three-year freedom from all cause death were 97.3% and 77.7% in the LMCA group and non- LMCA group, respectively (p = 0.17), and the corresponding rates for the combined endpoint of myocardial infarction, angina pectoris, repeat coronary intervention, and heart failure were 80.4% and 70.4% (p = 0.98).*

Conclusions: *Off-pump coronary artery bypass grafting is feasible and safe in patients with critical LMCA stenosis and LMCA disease is not recognized as a risk factor after off-pump coronary artery bypass grafting in either the short or the Mid-term.*

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Introduction:

Left main coronary artery (LMCA) disease (e"50%) is a significant independent predictor of mortality in patients with ischemic heart disease. Patients with LMCA stenosis are recognized to be at increased risk when receiving medical therapy alone compared to surgical revascularization.[1-3] Coronary artery bypass grafting (CABG) is the standard therapy for patients with LMCA disease. Off-pump coronary artery bypass grafting (OPCAB) has recently become widely popular globally, and has produced good clinical outcomes. However, patients with LMCA stenosis have been excluded from off-pump coronary artery revascularization due to concerns about the heart's ability to tolerate surgery.[4-6] Recently, some reports have shown that OPCAB is safe and effective in patients with critical LMCA stenosis.[7-13]

The purpose of this study was to compare the safety of multivessel bypass grafting in patients with or without left main coronary artery disease (≥50%) using current beating heart surgical techniques.

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Methods:

All patients had given informed written consent for the use of their medical records for research purposes. The Institutional Review Board and the ethical committee approved this study. From March 2020 to December 2021, a total of 437 patients, 159 of whom had significant LMCA disease, underwent isolated OPCAB surgery under a single Cardiac surgeon at Khulna City Medical College Hospital. For one-to-one match pairs and removing confounding factors, We have calculated a propensity score for LMCA disease with similar clinical characteristics. Logistic regression with backward selection was performed to calculate the propensity score. By matching propensity scores, 100 pairs were successfully matched in a one-to- one manner. We compared the characteristics and clinical results between these propensity-matched groups. We performed OPCAB in all CABG cases. Patients with emergency cases and patients who had undergone a salvage procedure were excluded from the study. Pre-operative Chronic renal failure was defined as the Serum creatinine >1.4. Postoperative stroke or cerebrovascular accident was defined as a new neurologic event persisting for more than 24 hours after onset and was confirmed by computed tomography. Follow-up was achieved by direct communication with the patient, and the patient's family. Significant LMCA disease was defined as LMCA with stenosis greater than or equal to 50%, assessed visually by the physician performing the coronary angiography.

Anesthetic and Surgical Techniques

A standard general anesthetic technique was used for all CABG patients. The induction of anesthesia was achieved with fentanyl citrate (5 to 10 ìg/kg), thiopental (3 to 5 mg/kg), or propofol infusion (3 to 4 mg/kg/hour), and Atracurium Besylate (0.4-0.5 mg/kg). Anesthesia was maintained with fentanyl, propofol (2 to 3 mg/kg), and low concentrations of sevoflurane if necessary. Anticoagulation was achieved with heparin (1 mg/kg) after the conduits were harvested and the activated clotting time was maintained at 250 seconds or greater. Heparin was reversed with protamine after the completion of the anastomosis. Standard peri-operative monitoring techniques were used.

All procedures were performed through a median sternotomy. The conduits (one or both skeletonized internal thoracic arteries and saphenous vein) were harvested. We used a suction-type mechanical stabilizer (Octopus 4.3; Medtronic, Minneapolis, MN) to immobilize the target coronary artery. An intracoronary shunt was used routinely. The distal anastomosis was constructed with 7-0 or 8-0 polypropylene using a standard technique.

Statistical Analysis

Continuous variables were presented as mean ± standard deviation (SD) and were compared by Student's t –test or the Mann-Whitney U test. The chi-square test (when all expected cell counts were five or more) or Fisher's exact test (when any expected cell count were four or less) was used to determine the significance of differences in categorical variables. To get one-to-one match pairs with similar clinical characteristics we have calculated a propensity score for LMCA disease. Logistic regression with backward selection was performed to calculate the propensity score. The "concordance" statistic or C-index was calculated to assess the discriminatory ability of the model. Every patient with LMCA disease was then matched to one patient non LMCA disease using propensity scores identical to within 3%. Univariate and multivariate Cox proportional hazard regression analyses were performed for the analysis of mid-term mortality and cardiac event. The multivariate analyses were calculate with a stepwise forward regression model in which each variable with a probability value of less than 0.20 in the univariate analysis was entered in the model. Actuarial survival and event-free survival curves were estimated using the Kaplan- Meier method comparing differences between two groups with the log-rank test. Calculated p values of less than 0.05 were considered significant. Data were analyzed using SPSS 23 (SPSS Inc, Chicago, IL) for Windows.

Results:

The preoperative characteristics of the patients are summarized in Table I. Preoperative patient comorbidities and cardiac characteristics were equally distributed in the two matched groups.

The discriminatory ability of the logistic model as measured by C statistic was 0.63 ($p < 0.001$) and the Hosmer-Lemeshow goodness-of-fit test was not statistically significant (p = 0.83), indicating good discriminative power and acceptable calibration of the model, respectively.

Short-Term Results

Outcome after surgery is shown in Table II. There were no significant differences in the number of grafts per patient (3.34 ± 1.0 vs. 3.41 ± 1.2; p = 0.6546) or the rate of achievement of complete revascularization (98% vs. 96%; p = 0.6827). Bilateral internal thoracic artery use was higher in the Non LMCA group (20% vs. 25%; p = 0.4985). The rates of all arterial revascularization (18% vs. 21%) distributed in the two groups. There was no significant difference in other morbidities: perioperative myocardial infarction (2% vs. 1%), bleeding reoperation (3% vs. 2%), permanent stroke (1% vs. 2%), prolonged ventilator support for respiratory insufficiency (>24 hours) (6% vs. 7%). One patients in the LMCA group (1 of 100; 1%) died: due to low output syndrome. One patients in the non- LMCA group (1 of 100; 1%) died: due to multisystem organ failure.

Mid -Term Results

Follow-up was completed in 98% (196 of 200) of the patients. The follow-up duration was 3 years. Three- year freedom from death from all causes was 97.3 % in the LMCA group and 77.7 % in the non- LMCA group (p = 0.17); the rates of freedom from the combined endpoint of myocardial infarction, angina pectoris, repeat coronary intervention, and heart failure requiring treatment were 80.4 % in the LMCA group and 70.4% in the non-LMCA group (p = 0.98) (Figs 1; 2). Multivariate Cox proportional hazards regression analysis showed independent predictor of long-term cardiac events (cardiac death, myocardial infarction, angina pectoris, repeat coronary intervention, and heart failure) (Table III).

Table-I
Preoperative Patient Characteristics in Propensity Matched Groups

Characteristics	LMCA (n = 100)	Non- LMCA (n = 100)	P Value
Age (mean ± SD)	60.1 ± 9.2	61.2 ± 10.5	0.4317
Female Gender	39 (39%)	45 (45%)	0.4739
Smoker	61 (61%)	52 (52%)	0.2538
Hypertension	81 (81%)	78 (78%)	0.7264
Dyslipidemia	70 (70%)	63 (63%)	0.3688
Diabetes Mellitus	65 (65%)	59 (59%)	0.4665
COPD	5 (5%)	3 (3%)	0.7209
Previous Stroke	2 (2%)	6 (6%)	0.2790
Chronic Renal failure (S.Cr->1.4)	3 (3%)	5 (5%)	0.7209
EF (<40%)	35 (25%)	26 (36%)	0.2190
Previous Myocardial Infarction	22 (22%0	31 (31%)	0.1997
Peripheral arterial disease	6 (6%)	3 (3%)	0.4977

COPD = chronic obstructive pulmonary disease; S. Cr= serum creatinine; LMCA = left main coronary artery; EF left ventricular ejection fraction; SD = standard deviation.

Table-II

Operative and Postoperative Data

Variables	LMCA (n = 100)	Non-LMCA (n = 100)	P Value
IABP Use	0	0	1.0000
No. distal anastomoses	3.34 ± 1.0	3.41 1.2	0.6546
Complete	98 (98%)	96 (96%)	0.6827
Revascularization BITA use	20 (20%)	25 (25%)	0.4985
All arterial reconstruction	18 (18%)	21 (21%)	0.7218
Prolonged ventilation (>24 hours)	6 (6%)	7 (7%)	1.000
ICU stay (Hours)	22.1±23.3	22.2±22.8	0.9756
Re-operation for bleeding	3 (3%)	2 (2%)	1.0000
Deep Sternal Infection	0	0	1.0000
Permanent Stroke	1 (1%)	2 (2%)	1.0000
Peri-operative Myocardial Infarction	2 (2%0	1 (1%)	1.0000
Atrial fibrillation	10 (10%)	13 (13%)	0.6584
Renal Failure Requiring Dialysis	0	0	1.0000
Mortality	1 (1%)	1 (1%)	1.0000

BITA = bilateral internal thoracic arteries; IABP = intraaortic balloon pump; ICU = intensive care unit; LMCA = left main coronary artery.

Table-III

Univariate and Multivariate Cox Proportional Hazard Regression Analyses of Late Cardiac Events (Cardiac Death, Myocardial Infarction, Angina Pectoris, Repeat Coronary Intervention, and Heart Failure)

Variable	Hazard Ratio	95% Confidence Interval	P Value
Univariate model:			
Age	0.7	0.4 - 1.3	0.26
Female Gender	0.7	0.4-1.6	0.45
Smoker	1.3	0.7-2.2	0.37
Hypertension	1.6	0.8-3.2	0.15
Dyslipidemia	0.7	0.4 - 1.1	0.13
Diabetes Mellitus	0.8	0.5 - 1.4	0.39
COPD	1.3	0.7 -2.6	0.46
Previous Stroke	1.5	0.7-3.1	0.27
Chronic Renal failure (S.Cr->1.4)	1.5	0.7-3.1	0.27
EF (<40%)	0.3	0.1-0.9	0.03
Previous Myocardial Infarction	0.9	0.5 - 1.5	0.66
Peripheral arterial disease	1.5	0.7-3.4	0.31
Complete Revascularization	0.3	0.1-0.9	0.03
BITA use	0.9	0.6 - 1.7	0.81
Atrial fibrillation	1.4	0.8-2.7	0.25
Multivariate Model:			
EF (<40%)	NS		
Hypertension	NS		
Dyslipidemia	NS		
Complete Revascularization	NS		

BITA = bilateral internal thoracic arteries; IABP intraaortic balloon pump; ICU = intensive care unit; LMCA left main coronary artery. NS- not Significant; COPD = chronic obstructive pulmonary disease; S. Cr = serum creatinine; LMCA = left main coronary artery; EF=left ventricular ejection fraction;

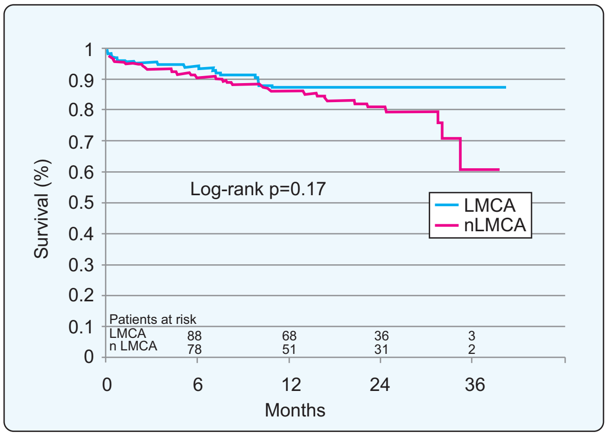

Figure 1: *Three-year actuarial freedom from death of any cause after off-pump coronary surgery according to LMCA (black line) or non-LMCA (grey line). (LMCA = left main coronary artery).*

Discussions

Past studies comparing medical therapy alone with surgical revascularization document a significant survival benefit for patients with critical left main coronary artery disease who undergo surgery.[1–3,14,15] Currently, CABG is recommended for patients with critical LMCA stenosis.[16,17] However, critical LMCA stenosis has been considered a risk factor for patients undergoing CABG.[5,6] Although these patients are high risk, long-term prognosis is improved by CABG compared to medical therapy or PCI alone. Numerous studies have identified the presence of LMCA disease as an independent predictor of postoperative morbidity and mortality in patients undergoing CABG.[5,6] These reports were based on data presented in the decade before 2000, when surgery, anesthesia, and medical management techniques were less advanced and technological than they are today.

Over time, there have been major improvements in almost all aspects of perioperative management of patients undergoing CABG. Coronary artery bypass grafting has advanced thanks to better management, with options including more frequent use of artery grafts, more use of internal thoracic arteries, and improved techniques in off-pump surgery.

Many recent reports have found that complete revascularization can be achieved by OPCAB with safely and feasibly, superior to or equal to conventional CABG with cardiopulmonary bypass, with excellent early and mid- and long-term clinical outcomes. While OPCAB for patients with LMCA stenosis remains challenging,[4] several recent reports have indicated the safety and efficacy of the technique in LMCA stenosis patients.[7–9,13] Yeatman and colleagues reported the safety and efficacy of OPCAB for critical LMCA disease through a comparison between 75 OPCAB cases and 312 conventional CABG procedures.[7] Lu and colleagues by using a risk-adjusted model evaluated OPCAB surgery compared with on-pump surgery.[13] In our OPCAB series, the number of distal anastomoses per patient was 3.34 in the LMCA group and 3.41 in the non-LMCA group, with complete revascularization achieved in 98% and 96%, respectively. There were thus no significant differences between the two groups. No patient in either group was converted from off-pump to on-pump. Operative mortality was 1% in the LMCA group and 1% in the non-LMCA group and postoperative morbidity was equally frequent in the two groups with no significant differences. These early-stage results of the study also indicated the feasibility and effectiveness of the OPCAB approach for patients with significant LMCA disease. Compared with previous studies, Cosgrove and colleagues[18] reported that LMCA disease was not an independent risk factor for postoperative mortality and cardiac events after CABG. Since their report, several studies have recorded equal early- stage survival in patients with LMCA stenosis compared with other patients and similar long- term survival after CABG.[18-20] Indeed, there was a pronounced decrease over time in the risk of both early and late death in patients with LMCA undergoing CABG shown by Jonsson and colleagues.[20] Its full complement includes technological advances in surgery, anesthesia and intensive care management. Improvement in medical management, including the use of statins, an effective dual anti-platelet drug, and Beta-blocker, was also a factor.

The present study showed a 3-year survival rate for all causes of death: 97.3% in the LMCA group and 77.7% in the non-LMCA group with no significant difference. Freedom from any cardiac event (myocardial infarction, angina pectoris, percutaneous coronary intervention, cardiac failure) was 80.4% in the LMCA group and 70.4%

in the non-LMCA group. We found no significant differences in early and mid-term clinical outcomes between the LMCA and non- LMCA groups. In the current study, LMCA stenosis was thus not recognized as a risk factor in short-term or mid-term outcomes after CABG.

Study limitation

A limitation of the present study is that it is nonrandomized and is a retrospective study comparing outcome in patients with and without LMCA disease undergoing OPCAB. Our study population was small, resulting in insufficient statistical power. However, all of the procedures were consecutive and conducted within a single center by a single cardiac surgeon. Additionally, comparison of preoperative demographic and risk factors demonstrated that the two cohorts were well- matched.

Conclusion

We can conclude that OPCAB is feasible and safe in patients with critical LMCA stenosis and that critical LMCA disease are not risk factors after OPCAB surgery either in the short or mid-term.

Conflict of Interest - None.

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