A SINGLE CENTRE EXPERIENCE WITH CORONARY ENDARTERECTOMY IN PATIENTS UNDERGOING OFF-PUMP CORONARY ARTERY BYPASS GRAFTING

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ABSTRACT

BACKGROUND

Coronary Artery Bypass Grafting (CABG) is one of the most frequently done cardiac surgical procedures. However, with the advancements in catheter-based interventional procedures, the category of patients taken up for CABG is gradually being restricted to more high-risk group. Additional surgical procedures like Coronary Endarterectomy (CE) are needed for treating such high-risk coronary artery disease to achieve complete revascularisation. Off-pump coronary endarterectomy can be performed safely with morbidity and mortality comparable with those of conventional coronary endarterectomy.

MATERIALS AND METHODS

This is a single institutional retrospective study with 480 patients underwent concomitant off-pump CE and CABG. Average number of coronary bypass grafts were 2.4±0.8. There were 321 cases of LAD endarterectomy with 246 receiving LIMA as the arterial graft. 2.9% patients were converted to on-pump surgery intraoperatively because of intraoperative hypotension.

RESULTS

The incidence of postoperative MI was 0.8%. The 30-day mortality was 0.8% from complications of bowel ischaemia and three patients with septicaemia associated with prolonged intubation. The mean operating time was 118±22 minutes.

CONCLUSION

We have shown that the effect of OPCABG with CE appears to be safe and early outcomes are encouraging. Hence, diffuse disease requiring endarterectomy should not be considered a contraindication to OPCABG. Surgical skills and the suitability criteria of the patients are very important in this regard.

KEYWORDS

Coronary Endarterectomy, Off-Pump Coronary Artery Bypass Grafting.

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BACKGROUND

Coronary Artery Bypass Grafting (CABG) is one of the most frequently done cardiac surgical procedures. However, with the advancements in catheter-based interventional procedures, the category of patients taken up for CABG is gradually being restricted to more high-risk group. High-risk profile is characterised by old age, severe left ventricular dysfunction, previous Percutaneous Coronary Intervention (PCI), diffuse Coronary Artery Disease (CAD) (i.e., at least 75% of the segment distal to the lesion has a vessel diameter of <2 mm) and comorbidities such as diabetes mellitus and peripheral vascular disease. Additional surgical procedures like Coronary Endarterectomy (CE) are needed for treating such high-risk coronary artery disease to achieve complete revascularisation. CE is removal of an atheromatous core by separating the external medial and

adventitial layers to restore lumen of artery. CE was first introduced in 1957 by Bailey et al. Earlier experiences of CE in 1960s and 70s were not associated with satisfactory results. However, with refinement in technique of CE, its benefits have now been recognised. CE on beating heart requires greater skill and surgical technique. The results of off-pump coronary endarterectomy are encouraging and comparable with the conventional coronary endarterectomy using cardiopulmonary bypass. Off-pump coronary artery bypass surgery reduces the likelihood of acute renal failure, reduced time of mechanical ventilation and decreased bleeding thus requiring less number of blood and blood products. The early results and particularly the midterm survival rates, clinical status and continued graft patency justify off-pump CE in patients with severely depressed left ventricular function and diffuse coronary artery disease. Off-pump coronary endarterectomy can be performed safely with morbidity and mortality comparable with those of conventional coronary endarterectomy. This study is a retrospective analysis of clinical profile and early surgical outcomes of patients undergoing CABG+CE in a tertiary care centre.

MATERIALS AND METHODS

This is a single institutional retrospective study. 480 patients from January 2013 to December 2015 underwent concomitant CE and CABG were included. The age range of patients was 38-77 years with mean age of 59.85±10.43 years. Out of them, 371 were males and 109 females. Diabetes mellitus (46%) and hypertension were the major risk factors. More than half (56%) of the patients had previous Myocardial Infarction (MI). Most of the patients (68%) had triple vessel disease. All patients signed in informed consent form before surgery.

Surgical Technique

All cases of CABG were done off-pump. Most of the CE were planned before surgery, but final decision was taken intraoperatively after coronary arteriotomy. Indications for CE were-

a. Multiple significant stenosis in same coronary artery.
b. Total occluded vessel supplying viable myocardium.
c. Occlusion along the entire length of artery.
d. Calcified vessel that makes suturing difficult.
e. For complete revascularisation with conventional CABG.

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Technique of CE

A. Closed or traction technique- After doing a longitudinal arteriotomy, if the vessel meets the above criteria for endarterectomy, the atheromatous core was carefully dissected and separated from the vessel wall by using fine forceps or spatula. Once the plaque is free circumferentially, gentle traction is applied first distally and then proximally. Simultaneously, counter-traction was applied with forceps to the adventitia of vessel wall while pulling and peeling the plaque from the vessel wall. A conventional distal anastomosis was then done using 7-0 polypropylene.

Completeness of CE was assessed by-

a. Length of end atheromatous core extracted.
b. Soft, tapering and bluish end.
c. Palpation of distal end of the vessel.

If on initial attempts, endarterectomy remains incomplete, either the arteriotomy was extended or a separate arteriotomy was done distally depending on the distance of the broken plaque from the initial arteriotomy.

B. Open or direct vision technique- After coronary arteriotomy, incision was extended both distally and proximally over the plaque. The atheromatous core was extracted with all side branches under direct vision. This technique was usually done for.
   a. Broken plaques during closed endarterectomy.
   b. Densely adherent plaque to the vessel wall.
   c. Calcified and fragile plaque.

In cases with separate distal arteriotomy, anastomosis was done using 8-0 polypropylene with a 2-mm shunt in the coronary artery by one of the following techniques.

a. A long on-lay patch angioplasty with LIMA/saphenous vein.
b. Free saphenous venous patch angioplasty. LIMA/saphenous vein graft's distal end was then anastomosed to the patch.

Proximal Portion

Attempt was made to extract the proximal portion of the atheromatous core by traction technique. However, in severely calcified and fragile plaques, proximal portion was sharply divided. The divided intima of the vessel was tacked with 8-0 polypropylene sutures. Proximal traction of plaque was carefully done to avoid proximal dissection and occlusion of a wide septal or oblique branch.

Perioperative Care

Care was taken to avoid hypotension during the perioperative period.

Anticoagulation Regimen.

Antiplatelet and anticoagulants were given to every patient postoperatively. Aspirin was started 6 hours postsurgery and warfarin was given next day onwards. Injection heparin was given four hours post-surgery (after excluding significant

mediastinal bleeding maintaining the ACT between 150 and 200 seconds). Daily INR reports were done. Heparin was stopped once INR was between 1.5-2. Patients were discharged with 150 mg aspirin and warfarin dose adjusted. After three months follow up, warfarin was stopped and Tab. Clopidogrel 75 mg was added.

Statistical Analysis

All statistical analysis was done using SPSS software. Continuous variables were reported as Mean±SD. Continuous variables were compared by χ^2 test or Fischer's exact test. Differences were considered significant at $p<0.05$.

RESULTS

In the past four years, 5466 CABG operations were performed at our institution excluding those with concomitant valve operations. 4988 (91%) of cases were Off-Pump Coronary Artery Bypasses (OPCAB). Four hundred eighty cases out of these included CE. The patient characteristics are mentioned in Table 1. The preoperative characteristics of patient are described in Table 2. The mean age was 59.6±10.4 years with male-to-female ratio of 3.4:1. 44% patients had severe LV dysfunction with 21% having LVEF less than 15 on preoperative echocardiography. 46% patients had diabetes mellitus and 34% were smokers. The preoperative lipid profile was deranged in 20% of the patients. Majority (68%) of the cases were triple vessel disease. 28 of the 480 patients were operated in emergency. 6.67% patients had preoperative IABP. Average number of coronary bypass grafts were 2.4±0.8. There were 321 cases of LAD endarterectomy with 246 receiving LIMA as the arterial graft. 2.9% patients were converted to on-pump surgery intraoperatively because of intraoperative hypotension. The incidence of postoperative MI was 0.8%. The 30-day mortality was 0.8% from complications of bowel ischaemia and three patients with septicaemia associated with prolonged intubation. The mean operating time was 118±22 minutes (Table 3).

Age (Years) (Mean±SD)	**59.85±10.43**	**Previous CVA**	**8 (1.7%)**
Sex (M:F)	3.4:1	COPD	38 (7.9%)
Smoking (No %)	133 (34.6%)	Prior stent	34 (7%)
Hypertension (No %)	211 (43.9%)	PVOD	11 (2.3%)
Diabetes mellitus (No %)	268 (46%)	Renal failure	22 (4.6%)
Dyslipidaemia (No %)	97 (20.2%)	Emergency cases	28 (5.8%)
Obesity (No %)	45 (9.3%)		
Family history of CAD (No %)	72 (15%)	Preoperative medication	
		Aspirin	480
Ejection fraction (No %)		ACE inhibitors	154
>55%	101 (21%)	Beta blockers	368
45-55%	130 (27%)	Diuretics	106
30-45%	139 (29%)	Antiarrhythmics	11
<30%	110 (23%)		
Old MI (No %)	267 (56%)	CAD pattern	
Unstable angina (No %)	58 (12%)	Single vessel disease	58 (12%)
Stable angina (No %)	77 (16%)	Double vessel disease	96 (20%)
Cardiogenic shock (No %)	29 (6%)	Triple vessel disease	326 (68%)

Table 1. Patient Characteristics (n=480)

Average number of grafts (Mean±SD)	2.4±0.8
Intraoperative arrhythmia (No %)	4 (0.83%)
Total endarterectomies (No %)	
(a) Single (b) Double (c) Triple	352 (73.3%) 108 (22.5) 20 (4.16)
Vessel wise (No %)	
(a) LAD (b) RCA (c) Diagonal (d) Ramus (e) OM	321 (66.8%) 222 (46.25%) 26 (5.41%) 16 (3.3%) 38 (7.91%)
LIMA used for Endarterectomy of LAD (No %)	246 (51.25%)
Conversion to On-Pump (No %)	14 (2.91%)
IABP insertion intraoperatively (No %)	21 (4.370)
Operation time (min.) (Mean±SD)	118±22
Total number of vessels bypassed	1221
LIMA (No %)	408 (33.41%)
Saphenous vein (No %)	813 (66.58%)
Operation time (min.) (Mean±SD)	118±22

Table 2. Operative Data (n=480)

Mortality (No %)	4 (0.83%)
Duration of intubation (hours) (Mean±SD)	6±4
Duration of ICU stay (hours) (Mean±SD)	36±11
Duration of hospitalisation (days) (Mean±SD)	6±2.2
Postoperative MI (No %)	3 (0.62%)
Preoperatively inserted IABP (No %)	32 (6.66%)
IABP duration (hours) (Mean±SD)	53±12
Inotrope requirement (hours) (Mean±SD)	24±12
Postoperative bleeding (mL) (Mean±SD)	350±150
Total unit of blood products transfused (per patient)	
Blood (Mean±SD)	1.2±0.5
Platelets (Mean±SD)	1.1±0.4
Fresh frozen plasma (Mean±SD)	0.8±0.4

Table 3. Postoperative Data (n=480)

Definition

Operative death- Death within 30 days of surgery.

Low output syndrome- Need for adrenaline of dopamine >5 µg/kg/min.

Perioperative MI- Positive result of new Q waves in ECG or presence of a persistent interventricular conduction defect or a progressive loss of R wave in precordial derivations along with echocardiographic evidence of new onset RWMA. Serial CK-MB levels were not done.

Respiratory failure- Requirement of prolonged (i.e. greater than 48 hours) ventilation or presence of pneumonia.

Postoperative CVA- Occurrence of new stroke or intracranial bleeding confirmed by computed tomography. In patients with preoperative stroke, postoperative stroke was defined as worsening of neurological deficit with new radiological findings.

Figure Showing Endarterectomy Specimens

DISCUSSION

There are few series reporting CE during OPCABG procedures. Careaga and colleagues[1] and Naseri and associates[2] reported 8 and 44 cases, respectively. Off-pump CABG surgery for multivessel myocardial revascularisation in high-risk patients has been shown to reduce the incidence of perioperative morbidity[3,4,5] and the period of hospitalisation.[6] The very low incidence of readmission to the intensive care unit (nurse-patient ratio 1:1, cardiac monitoring, immediate access to advanced cardiac life support, arterial line and pulmonary artery catheter placement, temporary pacemaker placement, mechanical ventilation, intra-aortic balloon placement and vasoactive continuous intravenous infusions), return to theatre for bleeding or tamponade, infection and stroke in these high-risk patients in our OPCABG series. The intubation time, intensive care unit stay and the length of hospital stay has remained low and comparable to the data in the literature. Two patient in our study had transient stroke with complete recovery, which concurs in the study of Naseri and associates[2] who reported no neurologic deficit.

Incomplete revascularisation has been shown to be one of the most important factors that affects perioperative morbidity, ventricular function, reoperation rate and early and late mortality.[7,8] The adequate revascularisation of the LAD is considered as a vital determinant of the patient's prognosis.[7,8] However, LAD endarterectomy is considered to be higher risk than other territories[9] and therefore maybe avoided by some surgeons. In our series of OPCABG with CE, the commonest site of CE was the LAD (66%).

Previously, the Internal Mammary Artery (IMA) has been used cautiously as a conduit to an endarterectomised vessel because of concerns regarding mismatch of luminal diameter.[10] With CCE, however, several authors have now reported satisfactory early and late clinical outcomes and luminal patency of IMA to an endarterectomised vessel compared with great saphenous vein.[11,12,13] The use of the IMA for reconstruction of the LAD leads to reduced perioperative myocardial infarction, improved early patency and improved 5-year survival.[14] We have therefore utilised the left IMA to LAD in 76% of our cases.

The endarterectomy technique of choice is still a matter of controversy.[10,11,12,13,14,15,16] We generally use the "traction technique" to perform endarterectomy. This technique is simpler, performed through a small incision and easier to reconstruct.[15,16] The potential risks include incomplete removal of the plaque and the "snowplow effect," namely, shearing-off the plaque in the side branches and there are chances of incomplete removal. To avoid this, we opened the vessel at a distal site to complete the endarterectomy. With the "open technique," the vision is better and that may lead to more complete removal of the atheroma from the coronary vessel and its side branches.[17,] The traction technique was therefore preferred in most cases with careful inspection of the atheroma after removal. Extending the arteriotomy was only performed if it was thought that there

was a residual plaque in the distal vessel. Myocardial contraction in the region of the LAD artery is more vigorous than the RCA territory that helps in the extraction of the distal atheromatous core by simple traction and makes it easier as compared with removal in the RCA. Myocardial Infarction (MI) secondary to acute graft closure is a major complication after CCE with a reported incidence of 1.5% to 19%[7,11,18,19] and is higher when CE is not performed. The incidence of MI in our patients who underwent OPCABG with CE is 0.8% (4 of 480) that is in well correlation with the OPCABG without CE in the literature. However, proper biochemical analyses for infarct would probably show a higher incidence, especially around day 3 or 4.[20] Naseri and associates[2] reported a higher postoperative MI rate of 6.8% after OPCABG with CE in totally occluded or greater than 50% stenosis. Djalilian and colleagues[11] reported an increased MI rate in endarterectomised vessels performed under cardiopulmonary bypass that were not completely occluded.[11]

To minimise the risk of acute graft or native-vessel thrombosis after CCE particularly for left-sided endarterectomies.[11,16,21,22] Routine intravenous infusion of heparin is recommended in the immediate postoperative period followed by warfarin for three months. However, our practice has remained the same.

The reported incidence of early mortality after CCE is between 1% and 15%[7,10,11,17,20,23,24,25,26,27] and is higher than that of patients undergoing CABG without CE in the same institutions. OPCAB-CE was associated with a low perioperative mortality ranging from zero in smaller case series to 2.8% in the largest study.[28] Furthermore, comparative studies demonstrate at least equivalent 30-day mortality between OPCAB-CE and ONCAB-CE.[29] In the context of OPCABG with CE, Careaga and associates[1] and Erylimaz and colleagues[26] reported a 30-day mortality of 0% in their small series. Naseri and associates[2] who compared CCE and OPCABG with CE reported a mortality of 2.2% in a series of 44 patients with the latter technique. In our larger series of 480 high-risk patients, the early mortality of 0.8% is in conjuncture with the world literature. Early death is reported to be higher after LAD endarterectomy[9] and in patients undergoing endarterectomy of more than one coronary artery.[10] We had large number of patients with multiple endarterectomies. Four early deaths in our series had single vessel endarterectomy. In our experience, endarterectomy of the circumflex and RCA territory is generally unnecessary when there is diffuse disease and extensive calcification due to the small caliber of the vessels. Naseri et al[2] retrospectively studied 88 patients undergoing either on- (n=44) or off- (n=44) pump CE. Overall, 30-day mortality was 3.4% (3/88; 1 OPCAB; 2 ONCAB) with postoperative MI occurring in 5.7% (5/88; 3 OPCAB; 2 ONCAB). Perioperative neurological deficit occurred in 8.0% (7/88) all of which were in the ONCAB group. The authors conclude that OPCAB-CE confers comparable safety to ONCAB endarterectomy.

Similarly, in their prospective study of 115 patients (43 OPCAB; 72 ONCAB), Hussain et al observed comparable mortality (P=0.649), MI (P=0.576), AF (P=0.197), IABP use (P=0.295) and respiratory complications (P=0.211) between OPCAB-CE and ONCAB-CE. OPCAB-CE was associated with reduced ITU stay (P=0.007) and a trend towards a shorter intubation period (P=0.060) and reduced postoperative renal failure (P=0.075).

Owing to the increasing number of patients with diffuse coronary artery disease being referred for OPCABG, there is a need to reassess the early and medium-term postoperative outcomes in patients undergoing primary OPCABG with CE in modern cardiac surgery. Despite the higher risk profile, hospital mortality and major complications in our study have remained comparable to other studies.

CONCLUSION

We have shown that the effect of OPCABG with CE appears to be safe and early outcomes are encouraging. Hence, diffuse disease requiring endarterectomy should not be considered a contraindication to OPCABG. Surgical skills and the suitability criteria of the patients are very important in this regard.

REFERENCES

[1] Reyna CG, Garrido SD, Luna TS, et al. Coronary endarterectomy and bypass grafting without cardiopulmonary bypass. Rev Esp Cardiol 2003;56(5):515-518.
[2] Naseri E, Sevinc M, Erk MK. Comparison of off-pump and conventional coronary endarterectomy. Heart Surg Forum 2003;6(4):216-219.
[3] Al-Ruzzeh S, Nakamura K, Athanasiou T, et al. Does off-pump coronary artery bypass (OPCAB) surgery improve the outcome in high-risk patients?: a comparative study of 1398 high-risk patients. Eur J Cardiothorac Surg 2003;23(1):50-55.
[4] Berson AJ, Smith JM, Woods SE, et al. Off-pump versus on-pump coronary artery bypass surgery: does the pump influence outcome? J Am Coll Surg 2004;199(1):102-108.
[5] Sabik JF, Gilinov AM, Blackstone EH, et al. Does off-pump coronary surgery reduce morbidity and mortality? J Thorac Cardiovasc Surg 2002;124(4):698-707.
[6] Suzuki T, Okabe M, Handa M, et al. Usefulness of preoperative intraaortic balloon pump therapy during off-pump coronary artery bypass grafting in high-risk patients. Ann Thorac Surg 2004;77(6):2056-2059.
[7] Lawrie GM, Morris GC Jr, Silvers A, et al. The influence of residual disease after coronary bypass on the 5-year survival rate of 1274 men with coronary artery disease. Circulation 1982;66(4):717-723.
[8] Schaff HV, Gersh BJ, Pluth JR, et al. Survival and functional status after coronary artery bypass grafting: results 10 to 12 years after surgery in 500 patients. Circulation 1983;68(3 Pt 2):200-204.

[9] Livesay JJ, Cooley DA, Hallman GL, et al. Early and late results of coronary endarterectomy. Analysis of 3,369 patients. J Thorac Cardiovasc Surg 1986;92(4):649-660.
[10] Brenowitz JB, Kayser KL, Johnson WD. Results of coronary artery endarterectomy and reconstruction. J Thorac Cardiovasc Surg 1988;95(1):1-10.
[11] Djalilian AR, Shumway SJ. Adjunctive coronary endarterectomy: improved safety in modern cardiac surgery. Ann Thorac Surg 1995;60(6):1749-1754.
[12] Tasdemir O, Kiziltepe U, Karagoz HY, et al. Long-term results of reconstructions of the left anterior descending coronary artery in diffuse atherosclerotic lesions. J Thorac Cardiovasc Surg 1996;112(3):745-754.
[13] Gill IS, Beanlands DS, Boyd WD, et al. Left anterior descending endarterectomy and internal thoracic artery bypass for diffuse coronary disease. Ann Thorac Surg 1998;65(3):659-662.
[14] Beretta L, Lemma M, Vanelli P. Coronary open endarterectomy and reconstruction: short-and long-term results of the revascularization with saphenous vein versus IMA-graft. Eur J Cardiothorac Surg 1992;6(7):382-387.
[15] Goldman BS, Christakis GT. Endarterectomy of the left anterior descending coronary artery. J Cardiac Surg 1994;9(2):89-96.
[16] Mills NL. Coronary endarterectomy: surgical techniques for patients with extensive distal atherosclerotic coronary disease. Adv Cardiac Surg 1998;10:197-227.
[17] Ladowski JS, Schatzlein MH, Underhill DJ, et al. Endarterectomy, vein patch and mammary bypass of the anterior descending artery. Ann Thorac Surg 1991;52(5):1187–1189.
[18] Goldstein J, Cooper E, Saltups A, et al. Angiographic assessment of graft patency after coronary endarterectomy. J Thorac Cardiovasc Surg 1991;102(4):539-544.
[19] Sommerhaug RG, Wolfe SF, Reid DA, et al. Early clinical results of long coronary arteriotomy, endarterectomy and reconstruction combined with multiple bypass grafting for severe coronary artery disease. Am J Cardiol 1990;66(7):651-659.
[20] Taggart DP. Biochemical assessment of myocardial injury after cardiac surgery: effects of a platelet activating factor antagonist, bilateral internal thoracic artery grafts, and coronary endarterectomy. J Thorac Cardiovasc Surg 2000;120(4):651-659.
[21] Christakis GT, Rao V, Fremes SE, et al. Does coronary endarterectomy adversely affect the result of bypass surgery? J Card Surg 1993;8(1):72-78.
[22] Qureshi SA, Halim MA, Pillai R, et al. Endarterectomy of the left coronary system. Analysis of a 10 year experience. J Thorac Cardiovasc Surg 1985;89(6):852-859.
[23] Shapira N, Lumia FJ, Gottdiener JS, et al. Adjunct endarterectomy of the left anterior descending coronary artery. Ann Thorac Surg 1988;46(3):289-296.
[24] Wallsh E, Franzone AJ, Clauss RH, et al. Manual coronary endarterectomy with saphenous bypass (experience with 263 patients). Ann Thorac Surg 1981;32(5):451-457.
[25] Darwazah AK, Abu Sham'a RA, Yasin IH. Coronary endarterectomy on beating heart: is it worth doing? J Card Surg 2007;22(1):69-72.
[26] Eryilmaz S, Inan MB, Eren NT, et al. Coronary endarterectomy with off-pump coronary artery bypass surgery. Ann Thorac Surg 2003;75(3):865-869.
[27] Takahashi M, Gohil S, Tong B, et al. Early and mid-term results of off-pump endarterectomy of the left anterior descending artery. Interact Cardio Vasc Thorac Surg 2013;16(3):301-305.
[28] Vohra HA, Kanwar R, Khan T, et al. Early and late outcome after off-pump coronary artery bypass graft surgery with coronary endarterectomy: a single-center 10-year experience. Ann Thorac Surg 2006;81(5):1691-1696.
[29] Hussain I, Ghaffar A, Shahbaz A, et al. In hospital outcome of patients undergoing coronary endarterectomy: comparison between off-pump vs on pump CABG. J Ayub Med Coll Abbottabad 2008;20(1):31-37.