

Early and midterm results of Coronary Artery Bypass Grafting (CABG) in conjunction with the endarterectomy of Left Anterior Descending (LAD) Coronary Artery

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ABSTRACT

Aim: To review the early and mid term results of endarterectomy performed in conjunction with coronary artery bypass surgery on patients with diffuse coronary artery disease.

Method: The data of all patients undergoing open heart surgery at Rawalpindi institute of cardiology (RIC) was retrieved from our cardiac surgery database. The patients who underwent coronary endarterectomy as adjunct to CABG by single one team of surgeons (n=76) between March 2013 to January were identified. These were 76 patients out of whom 41 patients underwent endarterectomy of LAD. Further analysis was done on these 41 patients which included men and women. All continuous variables were expressed as mean±SD. Categorical variables were expressed as numbers and percentages.

Results: A total of 47 vessels underwent endarterectomies. These included 35 isolated LADs, three LADs in combination of RCAs and three LADs in combination of obtuse marginal branches. The cardiopulmonary bypass time was 130.95±5.76 min and the aortic cross clamp time was min. Average number of grafts were 2.77±0.87. The average ICU stay was 29.02±13.99 hours and mean Hospital stay was 7.55±3.29 days. Two patient died within 30 days of surgery. One death was due to multiple organ failure and one due to peri-operative myocardial infarction. There was no death in the follow-up period which ranged from 5 to 24 months.

Conclusion: We conclude that LAD endarterectomy is a safe and highly rewarding procedure in potentially inoperable patients.

Keywords: Diffuse Coronary Artery Disease, Coronary Endarterectomy, Coronary Artery Bypass Grafting

INTRODUCTION

Because of recent advances in percutaneous coronary interventions (PCI), the patients referred for coronary artery bypass grafting (CABG) are more likely to have diffuse coronary artery disease¹. These patients pose a great challenge to the surgeon as it is difficult to achieve adequate revascularization which is the most important goal of CABG surgery. The complexity of surgical procedure has increased because in these diffusely diseased and calcified vessels anastomosis is difficult to perform and plaque needs to be removed in order to facilitate anastomosis and provide adequate revascularization. Coronary endarterectomy (CE) was 1st introduced in late 1950s by Bailey for the relief of angina. At that time it was not combined with CABG². But the subject remained controversial due to fears of increased morbidity and mortality.

Over the past three decades there has been a re-emergence of coronary endarterectomy as adjunct

to CABG. However the incidence of coronary endarterectomy performed in combination with CABG varies from 3.7% to 42%, reflecting a lack of consistency for its indications^{3,4}. Recently encouraging results of coronary endarterectomy have been demonstrated in many series and now it is being considered a safe and effective procedure. Recent report have also suggested that it can be done safely without using cardiopulmonary bypass in Off-Pump Coronary Artery Bypass (OPCAB) operations^{4,5}.

PATIENTS AND METHODS

Data of all patients undergoing open heart surgery at Rawalpindi institute of cardiology (RIC) is entered into a dedicated electronic database (CASCADE Databases, Lahore, Pakistan). Ethical approval was taken from the Ethical Review Committee of the Institution to conduct this retrospective analysis. The data was retrieved in the form of Excel (Microsoft Inc) spreadsheet and was analyzed used the same software. Postoperative myocardial infarction (MI) was defined as new Q waves in at least two leads,

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ST-segment elevation with segmental wall motion abnormality in the same area or conduction blocks on ECG. All continuous variables were expressed as mean \pm standard deviation. Categorical variables were expressed as frequency and percentage. The Table 1 summarizes all numeric pre-operative, operative and post-operative variables.

The database analysis revealed 76 patients, who underwent CABG in conjunction with coronary endarterectomy between April 2, 2008 and January 31, 2015 one surgical team headed by the senior author (AJ). Out of these 76 patients 41 patients underwent endarterectomy of LAD endarterectomy. Table 2 shows the break-up of these cases according to the endarterectomized coronary artery. The patients with combined procedures like CABG with Carotid Endarterectomy or CABG with valvular surgery were excluded from the study.

All patients included in the study underwent conventional CABG through full midline sternotomy. Left internal mammary artery (LIMA) and Saphenous vein (SVG) were prepared for grafting. Cardiopulmonary bypass (CPB) was established and procedure was done on mild hypothermia, cross clamping of aorta and cardiac arrest with antegrade blood cardioplegia. Most endarterectomies were planned before surgery but final decision was made intra operatively, once the LAD had been exposed. If the initial arteriotomy revealed a severely diseased and occluded lumen, unsuitable for grafting, the arteriotomy was extended proximally and distally until the plaque tapered or a reasonable lumen was reached. Watson cheyne dissector and forceps were used to carefully dissect and lift the plaque off the vessel wall. Care was taken to ensure that the entire core along with its branches, was excised. The proximal and distal ends of the tapering plaque were divided sharply with no.11 blade. The distal intimal edges were stabilized and laterally tacked down to the vessel wall using interrupted 7/0 polypropylene sutures. The LIMA or SVG was then opened to the appropriate length and an onlay patch angioplasty type of anastomosis was performed with LIMA or SVG being anastomosed to the LAD in an end to side fashion using 7/0 polypropylene sutures. When vein patch was used to reconstruct LAD, LIMA was then applied to the hood of the vein patch.

In a few patients closed technique for endarterectomy was used in which a small arteriotomy was created and gentle steady traction was applied to the atheromatous plaque until it comes apart from the native artery proximally and distally.

Vessels other than LAD were revascularized using standard techniques and if endarterectomy in other vessels was required, it was performed and SVG was used as the conduit. Heparin was partially

reverted (we give half dose of protamine at the conclusion of operation). Hemostasis secured, drains placed and chest closed in a standard fashion. Postoperatively patients were maintained on dual antiplatelet therapy with Aspirin and Clopidogrel. The first postoperative dose was administered as soon as bleeding was controlled.

RESULTS

The patient's characteristics are summarized in Table 1. The total number of patients in this series was 41. There were 31 (75.6%) male and 10 (24.4%) female patients. Their mean age was 57 ± 7.5 years. Three vessel disease was present in 37 patients. Three patients had two vessel disease while one patient had single vessel disease. Six patients had significant stenosis of left main stenosis. All patients had normal body weight. The preoperative haemoglobin, serum creatine and CK-MB levels were all within normal range.

The risk of operative mortality was calculated using three internationally adopted scoring systems i.e., Parsonnet Score, Additive EuroScore and Logistic EuroScore. The mean score ranged from 5.1 to 1.49 which represented moderate predicted mortality i.e. 2-5%.

The Table 2 shows the break-up of endarterectomies according to coronary vessel. Isolated LAD was on top of the list as isolated endarterectomies of all other vessels were excluded. The median number of bypass grafts was 3. The LIMA was used in 33 patients (80.52%).

The post-operative recovery was pleasingly uneventful. All patients were extubated within 4 to 6 hours of surgery. The median number of transfused packed RBC units were 2. The mean blood loss after surgery was 790 ml. This is an acceptable amount considering the fact that we do not fully reverse heparin after surgery and administer Aspirin within 6-hours of surgery.

There was no need for re-intervention for any cardiac related events. The palliation of angina was excellent (no angina) in 39 patients (95.16%). Two patients reported atypical chest pain of CCS Class II and were subjected to CT-angiography. They were found to have patent grafts. Two patients developed peri-operative myocardial infarction. The peak CK-MB levels within 24 hours of operation were also recorded as a marker of peri-operative myocardial infarction. The median value of peak CK-MB was 46 which precluded any peri-operative infarction. The median value of total hospital stay was 7-days. It is just customary in our society that they patients expect to stay in hospital for at least one week. It is justifiable in the sense that primary healthcare is not as developed

as in the advanced nations. Therefore, hospital stay may appear too long by western standards but is satisfactory in our practice. There were two in-hospital deaths (4.88%) within 30-days of operation. Out these two deaths, one patient underwent urgent operation and died of peri-operative infarction while the other patient died of multiple organ failure.

Table 1: Preoperative, operative & postop characteristics

Variable	Median	Mean	Standard Deviation
Preoperative variables			
Age (years)	57	57.95	7.5
Height (cm)	165	165.87	9.18
Weight (kg)	60	70.65	10.08
Body surface area (m ²)	1.77	1.8	0.15
Body Mass Index (kg/m ²)	25.64	25.77	3.63
Pre-operative Ejection Fraction (%)	55	51.95	9.54
Creatine (mg/dl)	0.9	0.89	0.21
CK-MB (IU/l)	22	19	6.29
Risk scores			
Parsonnet Score	3	5.1	5.62
Additive EuroScore	2	1.51	1.21
Logistic EuroScore	1.33	1.49	0.61
Postoperative variables			
Bypass Time (min)	128	130.95	35.76
Cross Clamp Time (min)	86.5	84.80	24.84
ICU Stay (hrs)	24	29.02	13.99
Peak CK-MB (IU/l)	46	66.77	75.88
Ventilation Time (hrs)	4	5.61	3.94
Duration of Intropes (hrs)	18	22	21.47
Chest drainage (ml)	790	942.25	476.16
Hospital Stay (days)	7	7.55	3.29

Table 2: Break-up of endarterectomies according to endarterectomized coronary arteries

Coronary artery	n	Endarterectomies
Isolate LAD	35	35
LAD + RCA/PDA	3	6
LAD + OM	3	6
Total	41	47

DISCUSSION

Major objective of CABG is maximum revascularization, which provides improved early and late outcome after surgery. However, maximum revascularization is not always possible in diffusely diseased vessels especially diffusely diseased LAD with the conventional CABG techniques, as graft to distal LAD alone cannot provide a sufficient blood supply to the side branches, including septal perforators and diagonal branches. Accordingly

techniques such as long coronary arteriotomy, patch reconstruction or endarterectomy beyond the diseased segment are necessary to obtain adequate revascularization. Patients with diffuse coronary artery disease in whom standard CABG technique cannot be used constitute 0.8% to 25.1% of all patients with coronary artery disease⁶.

Coronary endarterectomy has been usually performed on vessels other than LAD. There has been reluctance to perform this procedure on LAD because of the fear of acute graft failure, major perioperative myocardial infarction and reduced graft patency rates following LAD endarterectomy. The improvements of surgical technique and peri-operative management has changed this myth and a growing number of surgeons now believe that endarterectomy can be performed safely^{7,8}. It is perhaps the time to look at the current results and to re-evaluate the indication for this surgical technique. Other option for treating such cases include trans-myocardial laser revascularization (TMR) and angiogenic growth factor therapy with heart transplantation reserved for patients with more advanced disease and poorer left ventricle⁹.

In this retrospective study, we found that the early results after LAD endarterectomy and reconstruction using either vein patch or LIMA patch were excellent. Two (4.8%) patients died within 30 days of surgery. This is in accordance with the recent results in other series which show a perioperative mortality of 2.7% to 8%^{7,8,01,11,12}. Our relatively low mortality rate reinforces the trend seen in recent studies on endarterectomy. Better patient selection, myocardial protection, surgical technique and ICU management probably explain improved early mortality rates. More-over we invariably use LIMA as conduit even when the LAD is reconstructed with vein patch and this might be a reason of low mortality as reported by Beretta et al¹². During follow up period of 24 months (Range 6 months to 24 months) no patient died. Hence, the overall mortality at 24 months was also 4.8%. We experienced peri-operative myocardial infarction in 2 patients (4.8%). The incidence of peri-operative myocardial infarction has been reported as high as 10% in past¹³ but it has reduced significantly in recent reports [10]. Recent reported series are showing very low incidence of perioperative myocardial infarction mostly less than 5%¹⁰. We perform endarterectomies entirely on cardiopulmonary bypass though Off-pump LAD endarterectomy has also been reported with good results^{3,5,11,12}.

We follow a policy of fast-track extubation to minimize the durations and hazards of mechanical ventilation. Most patients were extubated within 6 hours. Mean ventilation time was four hours which is

the same for routine cases of CABG in our unit. Contrary to the fear that endarterectomies may lead to excessive post-operative bleeding the mean chest drainage in this series was 940 ml. This figure is quite satisfactory considering the fact that we do not reverse heparin completely at the conclusion and administer Aspirin within 6-hours of operation. Despite diffuse nature of disease, multiple risk factors and co-morbid conditions the ICU stay and total hospital stay were not longer than usual.

Postoperative follow up 100% complete and ranged between 5 to 24 months. Two patients developed recurrence of atypical chest pain and were further investigated by CT angiography which revealed patent grafts. There were no other adverse events during the follow up. Freedom from major adverse cardiac events have been reported to be around 90% at 1 year and around 80% at 5 year^{11,2,8,9,13,15,16,25}. Jan. D Schmitto⁴ and others^{12,15,16,21} have noted significant improvement in CCS and NYHA class in follow up period in patients with coronary endarterectomy and CABG. In our study CCS class improved significantly in all patients as all of them are free from angina and in NYHA Class I. The long term graft patency has been a major concern in case of endarterectomy of LAD. Fukui et al⁸ and Qiu et al¹¹ have reported > 89% patency of such graft. Schweh et al¹⁴ have reported actuarial graft patency rates of 100%, 96% and 56% at 2, 5 and 10 years. We do not perform routine coronary angiography or CT angiography unless required on medical grounds.

Optimal technique for performing coronary endarterectomy (CE) is controversial. There are two surgical methods, designated the closed and open method. The closed method is carried out by traction of the endarterectomized intima through small arteriotomy. There are several disadvantages which include the possibilities that diagonal branches and septal perforators may be torn off despite gentle traction and that the distal lumen may become occluded with thrombus or dissection owing to insufficient endarterectomy. On the other hand, although the open method (long arteriotomy and total removal of plaque under direct visualization) requires a longer time, the opening of the side branches and distal end of the LAD can be directly observed and confidently endarterectomized using this method. Further more we can fix the divided intima of the distal LAD to secure the distal flow using this method. We have adopted the open method with good results. We think that our choice of technique contributed to the favorable outcome in this study. The open method allows for total removal of plaque and direct observation of side branches, septal perforators and distal LAD, which ensures distal

good runoff. It requires reconstruction patch of LIMA or saphenous vein. There is evidence that the reconstruction method (vein or LIMA patch) does not have significant impact on early and long term survival and graft patency, however grafting of LIMA on the patch does have beneficial effects over using vein graft alone^{10,15}. We also noticed that there was no difference in early and mid-term outcome whether the LAD was reconstruction with LIMA or patch of vein. However long term follow up is required to further comment on this issue.

It is important to minimize the occurrence of thrombosis at the endarterectomized site in immediate postoperative period. We give half dose of protamine at the conclusion of operation and start antiplatelets as soon as the drainage is settled. We give 300 mg Aspirin within 6 hours after surgery and start combination of Aspirin and Clopedogrel. Some authors describe use of Heparin infusions, followed by Warfarin for several months^{4,12}. This practice was more common before the advent of Clopidogrel. We therefore do not use Heparin or warfarin and rely entirely on combination of Aspirin and Clopedogrel. We follow a very aggressive policy of secondary prevention and ensure that patient receives double anti-platelet therapy, statins and treatment of blood pressure and diabetes. Moreover life style modifications are encouraged in every patient. We believe that all these measures as important as performing good surgery for long term benefits.

Limitations : It is retrospective and observational study hence without randomization. Number of patients is relatively small. Therefore it has all the usual limitations of retrospective studies.

CONCLUSION

The results of this study show that endarterectomy of left anterior descending coronary artery is a safe and highly rewarding procedure in potentially inoperable patients with diffuse coronary artery disease.

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