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CORONARY ENDARTERECTOMY AND PATCH ANGIOPLASTY FOR DIFFUSE CORONARY ARTERY DISEASE. A PROSPECTIVE ANALYSIS OF 22 CASES

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Abstract

Diffuse coronary artery disease (CAD) is a surgical challenge in which conventional coronary artery bypass grafting (CABG) may not achieve adequate myocardial revascularization unless adjuvant procedures such as coronary endarterectomy and coronary patch angioplasty (CPA) are added. The aim of this prospective study is to evaluate the outcome of these procedures in our institution in view of the relevant literature.

Data of all patients who underwent CPA±CABG by one surgeon in our institution (n=22) between April 2018 and April 2019 were collected. Patients underwent open coronary endarterectomy and onlay patch of left internal mammary artery (LIMA) or a venous patch under cardiopulmonary bypass (CPB).

Of 167 CABG procedures, 22 were combined with CPA. There were 15 (68.2%) males. Age ranged between 43-72 years with a mean of 59. patients included 19 isolated left anterior descending arteries (LADs), two right coronary arteries and one obtuse marginal branch. The CPB time was 88-198 minutes and the aortic cross clamp time was 40-125 minutes. The patients had (including LAD) 2-4 vessel diseases. The average ICU stay was 29±14 hours and mean hospital stay was 5 days with no complications apart from atrial fibrillation (n=4, 18.2%). The follow-up period ranged from 4 to 14 months. On the 40th postoperative day, coronary CT angiography revealed patent grafts. No patient died due to CAD.

In conclusion, coronary endarterectomy and angioplasty is a safe and highly rewarding procedure in potentially inoperable patients with diffuse coronary artery disease.

Keywords: Coronary artery disease, endarterectomy, angioplasty, venous, patch, left anterior descending, left internal mammary artery.

Introduction

Coronary artery disease (CAD) is very common with a steady increase in its incidence worldwide. This is due to an increase in the prevalence of factors predisposing to atherosclerosis which is the underlying pathology of CAD. The risk factors for CAD include smoking, hypertension, diabetes mellitus (DM), hyperlipidemia, family history, obesity, beside sedentary life style and unhealthy diet[1].

Though percutaneous coronary intervention (PCI) plays an important role in the management of CAD[2], still surgery is needed. In conventional coronary artery bypass grafting (CABG), a conduit is used to bypass a stenosis or an occlusion of a coronary artery. The common conduits are the great saphenous vein graft (GSV) harvested from the leg or the left internal mammary artery (LIMA) of the patient. Less commonly, the radial artery can be used also as a conduit.

One of the main problems in coronary surgery is facing a patient with ischemic heart disease whose coronary arteries are ungraftable or inoperable due to diffuse lesions. Severe (diffuse) coronary lesions

means significant stenosis involving the entire length of the coronary artery, significant stenosis of 20 mm length or multiple significant bigger than 70% in the same artery separated by areas of apparently normal (but probably diseased) vessel[3-9]. The concept of surgical removal of atheromatous plaque from the diseased coronary artery (coronary endarterectomy) and patch angioplasty (CPA) is not new. The evolution of surgical technique for CPA belongs to David C. Sabiston and Donald Effler[10,11]. 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 disease[3]. These patients pose a great challenge to the surgeon as it is difficult to achieve adequate or complete 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.

The conventional surgical revasculari-zation techniques cannot provide adequate blood supply to diffusely diseased coronary arteries. Coronary endarterectomy was 1st introduced in late 1950s by Bailey for the relief of angina. At that time it was not combined with CABG[4]. 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 CPA as adjunct to CABG. However the incidence of CPA performed in combination with CABG varies from 3.7% to 42%, reflecting a lack of consistency for its indications[6,7]. Recently encouraging results of CPA have been demonstrated in many series and now it is being considered a safe and effective procedure. Recent reports have also suggested that it can be done safely without using cardiopulmonary bypass in Off-Pump Coronary Artery Bypass (OPCAB) operations[5,6]. The procedure of coronary endarterectomy and patch angioplasty is nicely presented in the article of Takahashia et al[9]. This study was conducted in order to evaluate the results of coronary endarterectomy and patch angioplasty for the treatment of severe diffuse CAD in view of the published relevant literature.

Patients and Methods

All patients (n=22) who underwent coronary endarterectomy and CPA together with CABG by one surgeon team in our institution between April 2018 and April 2019 were prospectively studied. During this period, patients underwent 167 CABG operations.

Ethical approval was taken from the Ethical Review Committee of the hospital to conduct this prospective analysis. The data was collected and displayed in the form of Excel (Microsoft Inc) spreadsheet and analyzed thereafter using the same software.

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 CAPs were planned before surgery but final decision was made intra operatively after exposure of the LAD or other target coronary arteries.

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. Jerald forceps and

Pot scissors 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 anastomozed 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. Vessels other than LAD were revascularized using standard techniques and If PAP in other vessels was required, it was performed and SVG was used as the conduit. Often the vessel to be patched is the last one to be grafted.

Heparin was partially reversed (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. All continuous variables were expressed as mean and SD. Categorical variables were expressed as numbers and percentages.

Results

In this study, 22 patients with coronary artery disease were enrolled. There were 15 males (68.2%) and 7 (31.8%) females with a male to female ratio of 2.14: 1. The age ranged between 43 and 72 years with a mean of 59±6.6. The peak incidence was in the 6th and 7th decades of life (n=18, 81.8%). The age and gender distribution is shown in Table I.

Table I: Age and Gender Distribution of the Patients

Age (years)	Male n (%)	Female n (%)	Total n (%)
41-50	3	0	3 (13.6)
51-60	5	4	9 (40.9)
61-70	6	3	9 (40.9)
71-80	1	0	1 (4.6)
Total	15 (68.2)	7 (31.8)	22 (100)

Dyslipidemia and hypertension were the top 2 risk factors; each was reported in 20 (90.9%) of patients as demonstrated in table II.

Table II: Risk Factors

Risk Factor	N (%)
Dyslipidemia	20 (90.9)
Hypertension	20 (90.9)
DM	13 (59.1)
History of smoking	8 (36.4)
Family history of IHD	15 (68.2)

The patients had 2-4 vessel diseases (including LAD) according to their angiographic data. This is shown in Table III.

Table III: Distribution of Patients according to the Number of Diseased Vessels.

Number of Diseased vessels	Number of Patients (%)
2-vessels	5 (22.7)
3-vessels	7 (31.8)
4-vessels	10 (45.5)
Total	22 (100)

Near one third of patients had 3-vessel disease and near half of the patients had 4-vessel disease while a minority (n=5, 22.7%) had 2-vessel disease. Distribution of patients according to the diseased coronary vessels is shown in Table IV.

Table IV: Distribution of patients according to the diseased coronary vessels

Name of Coronary Artery	Number of Patients (%)
LAD	22 (100)
Left Circumflex	1 (4.5)
RCA	11 (50)
OMA	17 (77.3)

All patients had LAD disease whereas half had RCA involvement and more than 3 quarters had OMA disease. Table V displays the operative parameters of the patients in this study.

Table V: Operative Parameters of the Patients.

Variable	Value
CPB time (minutes)	88-198 (mean=131.5)
Aortic Cross Clamp time (minutes)	40-125 (mean=86.4)
Number of distal anastomoses (n)	3.19±0.87
Length of saphenous patch (cm)	3.1±0.9

Relevant operative findings were calcified atheromatous plaques in all patients that were not reported in the preoperative angiography. There were no significant adverse intraoperative events. Venous patch angioplasty was done for LAD in 19 (86.4%) patients, RCA in 2 (9.1%) and 1 (4.5%) for OM. There were no other associated cardiac interventions apart from one patient that had a repair of regurgitant mitral valve. The patients were weaned from CPB smoothly and shifted to the intensive care unit with stable hemodynamics and without evidence of myocardial ischemia (neither ischemic ECG changes nor elevated cardiac enzymes). Sixteen (72.7%) of the patients were extubated 7 hours (range 6–8 hours) postoperatively while 6 smokers (27.3%) were extubated next morning as demonstrated in table VI.

Table VI: Postoperative data

Variable	Value
Duration on mechanical ventilation (MV) (hours)	10.1±5.4
Chest Tube Blood Drainage (ml)	854.5±99.9
Surgical Infection(n)	0
Postoperative AF(n)	4
Stay in ICU (Hours)	17-43
Stay in Hospital (days)	4-6

The mean postoperative bleeding was 855 ml (range 750-1000 ml). Patients were discharged from the Intensive care unit at the first or second postoperative day (17-43 hours). There were no postoperative cerebrovascular accidents, respiratory, hepatic, or renal complications. In the early postoperative period, all patients had mild to moderate chest pain whereas one patient had an associated dyspnea. The follow-up lasted for 10 months (range 4–14 months). All patients were symptoms-free apart from 3 who had dyspnea, tachypnea, chest pain or peripheral oedema. There was one case of sternal dehiscence. On the 40th postoperative day, all patients were examined with coronary CT angiography, which showed excellent results and all the grafts were patent. One patient died 60 days after surgery due to valvular heart disease but no one died due to CAD.

Discussion

Major objective of CABG is maximum revascularization, which provides improved early and late outcome after surgery. However, maximum re-vascularization of diffusely diseased vessels such as the LAD is not always possible with the conventional CABG techniques. Bypass grafts to distal LAD may not provide a sufficient blood supply to the septal perforators and diagonal branches[11].

Techniques such as long coronary arteriotomy, endarterectomy and patch angioplasty beyond the diseased segment may be 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 disease. Coronary endarterectomy has been usually performed on vessels other than LAD[9,10]. There has been reluctance to perform endarterectomy on LAD because of the fear of acute graft failure, major perioperative myocardial infarction and reduced graft patency rates following this procedure. The improvements of surgical techniques and perioperative management made growing number of surgeons to believe that endarterectomy can be performed safely. It is perhaps the time to look at the current results and to re-evaluate the indications for this surgical technique[9,10].

In this prospective study, we found that the early and midterm results after LAD endartrectomy and reconstruction using either vein patch or LIMA patch were excellent. We believe that coronary angioplasty is an effective adjunct technique to surgical revascularization of severe coronary lesions than coronary endartrectomy alone. There was a single death (4.54%) in this series 60 days after surgery. This is in accordance with the recently reported perioperative mortality of 2.7% to 8%[9,10,12-14].

Our relatively low mortality rate reinforces the trend seen in recent studies on endartrectomy. Better patient selection, myocardial protection, good surgical technique and ICU management probably explain improved low mortality rates. Moreover we invariably used LIMA as conduit even when the LAD is reconstructed with vein patch and this might be a reason for the low mortality as reported by some authors[14]. The incidence of perioperative myocardial infarction has been reported as high as 10% in the past but recently it has been reduced to <5%[12].

We performed endarterectomy entirely on cardiopulmonary bypass though off-pump LAD endarterectomy has also been reported with good results[5,7,13,14]. We followed a policy of fast-track extubation to minimize the durations and hazards of mechanical ventilation. Mean ventilation time was 10 hours which is the same for routine cases of CABG in our unit.

Our policy is to partially reverse heparin at the end of operation, keep the patient on heparin infusion for 16 hours and start Aspirin thereafter. In spite of that, our volume of drainage of 850 was quite satisfactory and contrary to the general fear that endartrectomy may lead to excessive post-operative bleeding.

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 4 to 14 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 [3,4,10,11,15-19]

Optimal technique for performing coronary endartrectomy 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 of the closed technique 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 endartrectomy. 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. Furthermore we can fix the divided intima of the distal LAD to secure the distal flow using this method[9].

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[12,17].

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 anti-platelets as soon as the drainage is settled. We followed a very aggressive policy of secondary prevention of ischemic heart disease. Besides receiving double anti-platelet therapy, patients were prescribed statins. Moreover, anti-hypertensive and anti-diabetic treatments were given if indicated. Life style modifications were encouraged in every patient. We believe that such measures are as important as performing good surgery for achieving long term benefits.

In conclusion, despite the relatively small number of patients and their short follow up, the results of this study showed that coronary endarterectomy and CPA particularly of LAD is a safe and highly rewarding procedure in potentially inoperable patients with diffuse CAD. Therefore, coronary surgeons should have adequate training in the performance of such procedures so that patients with diffuse CAD and potentially inoperable or ungraftable vessels may be adequately revascularized.

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