MID-TERM RESULTS OF ENDARTERECTOMY IN ADVANCED CORONARY ARTERY DISEASE

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ABSTRACT:

OBJECTIVES

To compare the angiographic results of patency of endarterectomized vessels vs non endarterectomized vessels and their associated grafts after one year of coronary artery bypass grafting.

MATERIALS AND METHODS

Study was conducted at the Cardiology Department, Punjab Institute of Cardiology, Jail Road, Lahore from 1st October 2004 till 30th July 2006. 75 consecutive patients were included in the study after undergoing coronary artery bypass grafting and coronary endarterectomy in the hospital. All the patients included in the study were followed up prospectively after 1, 3, 6, 9 and 12 months of coronary artery bypass grafting and angiographic studies were performed at the end of 1 year of follow-up.

RESULTS

The mean age of the study population was 55.8±10.1 years. There were 64(85.3%) males and 11(14.7%) females. Hypertension and family history of ischemic heart disease both were present in 40(53.3%) patients. Diabetes mellitus was present in 23(30.7%) patients while 38(50.6%) patients were smokers. A total of 266 grafts were applied to these 75 patients. Of these 181 grafts were applied to non-endarterectomized vessels and 85 to endarterectomized vessels. Follow-up angiography revealed 6(3.3%) blocked grafts in a total of 181 non endarterectomized vessels. Of the 85 endarterectomized vessels, 4(4.7%) grafts with their parent vessels were blocked. Graft patency was not significantly different between endarterectomized and non-endarterectomized grafts (95.3% Vs 96.6%) p<0.11. All patients receiving LIMA to LAD had patent grafts at the end of one year. The blocked grafts were all SVGs.

CONCLUSION:

The angiographic graft patency rate of endarterectomized vessels and their associated grafts is similar to non endarterectomized vessels. For patients with refractory angina and severe diffuse disease, coronary endarterectomy is an acceptable therapeutic option.

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INTRODUCTION

The incidence of coronary artery disease is increasing. With the advancement of non-surgical methods to achieve myocardial revascularization, the patients coming for surgical revascularization has complex anatomy.[1] complete revascularization is the most important goal of coronary artery bypass surgery.[2-4]

Endarterectomy is the removal of atheromatous plaque, dissecting and separating the external medial and adventitial layers, thus restoring the lumen to the artery.[1] The first coronary endarterectomy was done by Bailey et al in 1957.[5] Because of increased morbidity and mortality this procedure had lost its importance.[6,7] Studies of coronary endarterectomy revealed that though there is an increase in surgical risk, it has good long term effect in selected group of patients.[8,9] In patients with total or subtotal obstruction of large coronary arteries there is no possibility to receive a conduit as a graft for myocardial revascularization in an area of viable ischemic myocardium, the need of an endarterectomy overtakes its disadvantages.[4,10] There are recent reports of safety and efficacy of this procedure with positive angiographic and clinical results.[8,9]

Early angiographic patency rate of 92.1% in on-lay patch bypass grafting group vs. 88.6% in conventional pull out method has been reported.11 Studies have reported a patency rate of endarterectomized grafts of 85-100%.[12-15]

Coronary artery bypass grafting has been locally studied[16,17] and a mortality of 1.5% without coronary endarterectomy has been reported.[17]

This study was designed to evaluate the post operative angiographic results regarding patency of the Coronary endarterectomized vessels and associated grafts one year after coronary artery bypass graft surgery (CABG).

MATERIALS AND METHODS

Study was conducted at the Cardiology Department, Punjab Institute of Cardiology, Jail Road, Lahore, from 1st October 2004 till 30th July 2006. 75 consecutive patients undergoing coronary endarterectomy were studied.

Patients undergoing coronary endarterectomy for severe coronary artery disease having more than 70 percent stenosis with length of diseased segment of ≥4 cm were included in the study. Patients having heavily calcified ectatic vessels, those with vessels with luminal diameter of ≤1 mm and those with diseased vessels supplying non viable myocardium were excluded.

Patients were included after undergoing coronary artery bypass grafting and coronary endarterectomy in the hospital immediately before discharge. Informed consent was taken from every patient before inclusion in the study. Brief history was enquired and general physical and systemic examination was done. Information regarding pre and post operative angiographic findings was noted. All information was entered on a predesigned proforma. In-hospital complications during the index admission were not studied and only those patients were included who remained uneventful during their hospital stay.

All patients included in the study were followed up prospectively after 1, 3, 6, 9 and 12 months of coronary artery bypass grafting with coronary endarterectomy. On every follow-up visit patients were inquired about any symptoms of coronary ischemia or left ventricular failure and detailed examination was done. If patients had symptoms typical of angina anytime within one year of surgery then stress thallium scan was carried out to look for target vessel ischemia. If scan positive for target vessel ischemia then graft study was performed early to confirm the results of stress thallium and angiographic patency of endarterectomized vessel and associated grafts. Patients who remained asymptomatic for one year were scheduled for coronary angiography after the end of follow-up period to see the angiographic patency of endarterectomized vessel and associated grafts, since every patient underwent coronary artery bypass grafting without coronary endarterectomy of one or two vessels in addition to the endarterectomized vessel. Proforma was updated on each follow-up visit for each case.

Angiography protocol:

All patients were consented to undergo post operative coronary angiography. The quality of the anastomoses were graded according to the classification of Fitzgibbon and colleagues.[18] Grade A stands for excellent graft patency, grade B for graft stenosis of greater than 50% and grade O for occlusion. String sign which was defined as a severe and extensive narrowing of the whole body of the graft was classified as grade B anastomosis.

STATISTICAL ANALYSIS

Statistical analysis was performed using the SPSS (release 12.0; SPSS, Inc; Chicago, IL) system for Windows. Categorical data was expressed as numbers and percentages while numerical data as mean ±Standard deviations. Outcome of endarterectomy was reported as percentages. In order to study graft patency the grafts were divided into two groups; Group I endarterectomized vessels and associated grafts and Group II non endarterectomized vessels and associated grafts. Graft patency was studied individually in endarterectomized and non endarterectomized grafts and compared by using Chi square test and p values were calculated. A p value of less than 0.05 was taken as significant.

RESULTS

The mean age of the study population was 55.8±10.1 years. There were 64(85.3%) male patients and 11(14.7%) female patients. Hypertension and family history of ischemic heart disease were more frequently present and occurred in 40(53.3%) patients individually. (Table 1). Diabetes mellitus was present in 23(30.7%) patients while 38(50.6%) patients were smokers.

Majority of patients 66(88.0%) had stable coronary artery disease (Table 1). ST segment elevation myocardial infarction (STEMI) was the admission diagnosis in 4(5.3%) patients while 5(6.7%) patients had non ST segment elevation myocardial infarction (NSTEMI). Preoperative coronary angiography revealed three vessel coronary artery disease in 64(85.3%) patients followed by left main stem disease along with multivessel coronary artery disease in 5(6.7%) patients and double vessel coronary artery disease in 5(6.7%) patients (Table 1). Among patients with three vessel disease, 32(42.7%) received 3 grafts, 29(38.7%) four grafts and 9(12%) received five bypass grafts, including the endarterectomized graft. Among patients with left main stem with multivessel disease, 3(60%) had four grafts, 1(20%) had five grafts and 1(20%) had three

TABLE 1.DEMOGRAPHIC DATA

Characteristics	Numbers(Percentages) n=75
Age	55.8±10.1
Male	64(85.3%)
Female	11(14.7%)
Hypertension	40(53.3%)
Diabetes mellitus	23(30.7%)
Hyperlipidemia	25(33.3%)
Smoking	38(50.6%)
Family history of IHD	40(53.3%)
Obesity	15(20%)
Presenting Diagnosis	
Stable angina	66(88%)
STEMI	4(5.3%)
NSTEMI	5(6.7%)
Pre op Angiography	
SVCAD	1(1.3%)
DVCAD	5(6.7%)
TVCAD	64(85.3%)
LMA+MVCAD	5(6.7%)

Stable CAD=Stable coronary artery disease; **STEMI**=St segment elevation myocardial infarction; **NSTEMI**=Non ST segment elevation myocardial infarction; **LMS+MVCAD**=Left main stem + Multi vessel coronary artery disease; **TVCAD**=Three vessel coronary artery disease; **DVCAD**=Double vessel coronary artery disease; SVCAD=Single vessel coronary artery disease; **IHD:** Ischemic heart disease.

grafts. In patients of double vessel disease, 2(40%) had three grafts each and 3(60%) had 2 grafts.

A total of 266 grafts were applied to these 75 patients undergoing coronary artery bypass grafting and coronary endarterectomy. Of these 181 grafts were applied to non-endarterectomized vessels and 85 to endarterectomized vessels. Majority of patients 32(42.7%) had 3 grafts applied followed by 29(38.7%) patients who had 4 grafts while 9(12%) had 5 and 4(5.3%) patients had 2 grafts applied respectively. (Table 2).

30(40%) patients followed by RCA in 20(26.7%) patients and OM1 in 4(5.3%) patients. (Table 3). Four patients had endarterectomy of LAD and RCA, while four others underwent endarterectomy of LAD and D1.

The mean intubation time was 11.7±8.14 hours while mean ICU stay was 48.5±26.27 hours and mean post operative stay was 9.85±6.16 days.

All patients were followed up for one year. 60(80%) patients did not have any symptoms at the end of 1

TABLE 2. NUMBER OF GRAFTS APPLIED AND DISEASED VESSEL DISTRIBUTATION

VARIABLE	NUMBERS(PERCENTAGES)
NUMBER OF GRAFTS APPLIED per patient	
1 graft	1(1.3%) patients
2 grafts	4(5.3%) patients
3 grafts	32(42.7%) patients
4 grafts	29(38.7%) patients
5 grafts	9(12%) patients
Total grafts	266
LIMA	71(26.6%)
SVGs	195(73.4%)
DISEASED VESSEL	**NUMBER OF GRAFTS**
LAD	**LIMA 71(94.7%)**
	SVG 4(5.3%)
RCA	**55(73.3%)**
CIRCUMFLEX	**33(44%)**
D1	**28(37.3%)**
OM1	**27(36%)**
PDA	**14(18.7%)**
OM2	**14(18.7%)**
RAMUS INTERMEDIUS	**14(18.7%)**
PLV	**4(5.3%)**
D2	**3(4%)**

LIMA=Left internal mammary artery; **SVGs**=Saphenous vein grafts.
LAD: Left Anterior Descending Coronary Artery; **RCA:** Right Coronary Artery; **LCx:** Left Circumflex Coronary Artery; **PDA:** Posterior Descending Artery; **PLV:** Posterior Left Ventricular Branches; **OM1:** First Obtuse marginal branch; **OM2:** Second Obtuse marginal branch; **D1:** First diagonal; **D2:** Second diagonal.

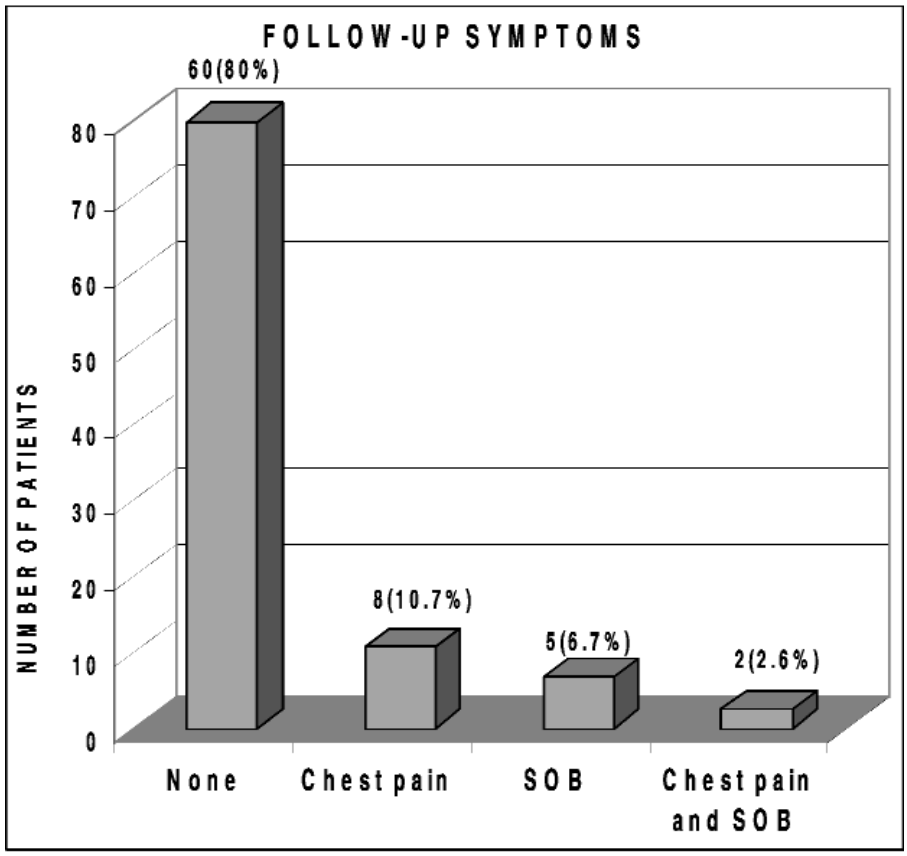
All patients received grafts to LAD with 71(94.7%) patients having LIMA to LAD and 4(5.3%) patients had saphenous vein grafts to LAD. (Table 2). After the LAD, RCA was the most commonly grafted vessel in 55(73.3%) patients followed by LCx grafting in 33(44%) patients.

Majority of the patients 65(86.6%) had coronary endarterectomy of a single vessel followed by 10(13.3%) patients who had endarterectomy of two vessels. LAD was selected for endarterectomy in

year. Most common symptom was chest pain which occurred in 8(10.7%) patients followed by shortness of breath in 5(6.7%) patients and a combination of chest pain and shortness of breath in 2(2.6%) patients (Figure 1).

One patient presented to the hospital within the first month complaining of chest pain and was found to have an anterior wall myocardial infarction. (Table 4). He underwent coronary angiography and graft study which revealed blocked SVG to

FIGURE 1. RESULTS OF FOLLOW UP STUDY



SOB: Shortness of breath.

TABLE 3. CORONARY ENDARTERECTOMY VESSEL DISTRIBUTION

ENDARTERECTOMIZED VESSEL	NUMBER (PERCENTAGES)
RCA	20(26.7%)
LAD	30(40%)
OM1	4(5.3%)
LAD+D2	4(5.3%)
RCA+LAD	4(5.3%)
D1	3(4%)
RI	3(4%)
PDA	2(2.7%)
LAD+RI	1(1.3%)
OM2	1(1.3%)
PLV	1(1.3%)
RCA+RI	1(1.3%)
D2	1(1.3%)

LAD: Left Anterior Descending Coronary Artery; **RCA:** Right Coronary Artery; **LCx:** Left Circumflex Coronary Artery; **PDA:** Posterior Descending Artery; **PLV:** Posterior Left Ventricular Branches; **OM1:** First Obtuse marginal branch; **OM2:** Second Obtuse marginal branch; **D1:** First diagonal; **D2:** Second diagonal; **RI:** Ramus Intermedius.

TABLE 4. OUTCOME OF FOLLOW-UP

CHARACTERISTICS	DURATION	NUMBER OF PATIENTS (%)
SYMPTOMS		
	1st MONTH	1(1.3%)
	3rd MONTH	2(2.7%)
	6th MONTH	3(4%)
	9th MONTH	5(6.7%)
	1 YEAR	4(5.3%)
POSITIVE STRESS THALLIUM SCAN		
	1st MONTH	0
	3rd MONTH	1(1.3%)
	6th MONTH	2(2.7%)
	9th MONTH	2(2.7%)
	1 YEAR	4(5.3%)
ABNORMAL GRAFT STUDY		
	1st MONTH	1(1.3%)
	3rd MONTH	1(1.3)
	6th MONTH	2(2.7%)
	9th MONTH	2(2.7)
	1 YEAR	4(5.3%)

endarterectomized D1. This patient had uncontrolled diabetes mellitus and poor compliance to medication. Two patients had chest pain within the first 3 months, out of which one had atypical features and was relieved by simple analgesics while the second underwent stress thallium scan which was positive for reversible myocardial ischemia. His graft study revealed patent endarterectomized vessel and associated graft while another SVG graft to non-endarterectomized OM1 had tight stenosis. Three patients had symptoms at the end of six months. All underwent stress thallium scan. Two of them had positive stress thallium scan for reversible myocardial ischemia so they were scheduled for graft studies. These revealed blocked SVG graft to endarterectomized D1 in one patient while the other had a blocked SVG graft to a non endarterectomized Ramus Intermedius. Five patients had symptoms at the end of nine months out of which two had chest pain and three had shortness of breath. Two of these had positive stress thallium scan and graft study revealed blocked SVGs to non endarterectomized vessels (OM1&D1). At the end of one year four (5.3%) patients had symptoms out of which two had chest pain and two had shortness of breath. All had positive stress thallium scan. Two of them had blockage of grafts to endarterectomized RCA and D1 while two had tight stenoses of non endarterectomized RCA and OM2. (Table 4).

Follow-up angiography revealed 6(3.3%) blocked grafts in a total of 181 non endarterectomized vessels. Of these 2 were SVGs to OM1, 1 SVG to RCA, 1 SVG to D1, 1 SVG to OM2 and 1 SVG to Ramus Intermedius. (Table 5). Out of 85 endarterectomized vessels, 4(4.7%) grafts with their patent vessels were blocked. Out of these one graft had been applied to RCA and 3 to D1. Graft patency was not significantly

TABLE 5. RESULT OF GRAFT STUDIES

CHARACTERISTICS	GRAFTS TO ENDARTERECTOMIZED VESSELS n=85	GRAFTS TO NON ENDARTERECTOMIZED VESSELS n=181	p value
Angiographic results			
Graft patency	81(95.3%)	175(96.7%)	<0.11
Graft blockage	4(4.7%)	6(3.3%)	<0.14

different between endarterectomized and non-endarterectomized grafts (95.3% vs. 96.6%) p<0.11.

All patients receiving LIMA to LAD had patent grafts at the end of one year. The blocked grafts were all SVGs.

DISCUSSION

Coronary endarterectomy without associated coronary artery bypass grafting (CABG) was introduced 40 years ago by Bailey and colleagues, performed initially without cardiopulmonary bypass (CPB). Currently coronary endarterectomy has a role as an adjunct to CABG, mainly in patients with diffuse coronary artery disease, to achieve more complete revascularization. Recent advances in the techniques of percutaneous coronary intervention (PCI) have resulted in more patients with diffuse disease being referred for CABG.[13] Patients referred for CABG are older and more often are afflicted with other co morbidities such as hypertension, diabetes mellitus, cerebral and peripheral vascular disease, renal dysfunction and chronic pulmonary disease. An early graft closure with lower long-term graft patency rates is the common concern after coronary endarterectomy, as the endarterectomized vessels tend to become thrombosed.[13]

In the current study angiographic graft patency of endarterectomized vessels and their associated grafts was similar to non endarterectomized vessels at the end of one year of follow-up and was 4.3% as compared to 3.7% in non-endarterectomized grafts. Our results are comparable to previous studies which have shown an angiographic graft patency of 72-100% in endarterectomized vessels and their associated grafts. [10-15, 19-23]

A study done by Chen ET al22 has shown 100% graft patency in endarterectomized grafts in patients undergoing coronary angiography from 3 to 27 months postoperatively. The study was conducted in China in 53 patients with diffuse coronary artery disease. These patients underwent 70 coronary endarterectomies with coronary artery bypass grafting without CPB. These included 38 endarterectomies carried out on LAD followed by 24 in RCA and 8 in LCx. Conduits used for bypass grafting were 53 LIMAs, 2 radial arteries and rest were saphenous vein grafts. There was no death while two patients had perioperative myocardial infarction. Forty four patients had 6 to 29 months follow-up with no recurrence of angina. In contrast to these findings, in our study one patient had myocardial infarction within 30 days of operation due to occlusion of endarterectomized coronary artery, while nine patients had angina with positive stress thallium scans. All patients with positive stress thallium had occluded grafts of which three were endarterectomized vessels and remaining six were non endarterectomized vessels.

Takanashi ET al15 have reported early angiographic graft patency rate of 96.2% for LIMA to LAD in patients undergoing off-pump coronary artery reconstruction, with or without endarterectomy for a diffusely diseased LAD. One hundred and eighteen patients were treated with an extended LAD reconstruction, with or without coronary endarterectomy. The LIMA was used to reconstruct the LAD without coronary endarterectomy in 63 patients and with endarterectomy in 55 patients. The operative mortality was 0.8%. Perioperative myocardial infarction was observed in 14.4% of the patients. Takanashi ET al[15] concluded that coronary artery reconstruction with or without endarterectomy, for a diffusely diseased LAD, can be performed with acceptable results. In our study, only 71(94.7%) patients received LIMA to LAD and LAD endarterectomy were carried out in only 39 patients while the remaining patients had endarterectomies of other vessels.

Nishi et al[11] from Japan have reported early angiographic results of 115 patients with a patency rate of 92.1% in on-lay patch bypass grafting group and 88.6% in conventional pull-out method. The size of angiographic study in coronary endarterectomy patients was larger in their study as compared to previous studies. The significance of study by Nishi ET al[11] is that they have prospectively studied a consecutive group of patients in order to obtain a true picture of the natural history of endarterectomized grafts, while previously most of the patency quoted in the literature involved selective restudy of certain groups of the original cohort. Nishi et al[11] have further reported that patency rate of coronary endarterectomy is dependent on coronary endarterectomy technique and coronary endarterectomy with On-lay patch

method does not increase the rate of graft failure despite the presence of diffuse coronary lesions. Therefore in their study long arteriotomy and LIMA On-lay patch grafting was considered to be the preferred method for performing coronary endarterectomy for diffusely diseased coronary arteries. Perioperative myocardial infarction also had a lower incidence in patients undergoing coronary endarterectomy with On-lay patch technique.

Sirivella ET al[13] have reported long term angiographic graft patency rate of 85% in endarterectomized vessels. Symptomatic patients on a long-term follow-up in their study underwent nuclear imaging and repeat coronary angiography in order to study graft patency of endarterectomized vessels. Their results are consistent with our study. They reported that despite higher risk profile, both short term and long-term outcomes after isolated coronary endarterectomy with CABG were either comparable or similar to conventional CABG. Furthermore in selected individuals with diffuse coronary artery disease coronary endarterectomy still remains a surgical tool for complete myocardial revascularization with an acceptable outcome.

Fukui ET al[12] have reported patency rate of LIMA to LAD of 98.6% by early angiographic examination. They studied 250 patients treated with an extended LAD reconstruction with or without endarterectomy as part of coronary artery bypass grafting to achieve complete revascularization. Coronary endarterectomy was performed in 67(26.8%) patients. The operative mortality was 1.6%. Perioperative myocardial infarction was observed in 6.4% of the patients. Fukui et al[12] believe that when diffusely diseased vessels having either continuous plaques with calcification, soft large plaques or hard fibrous plaques are found, they should not be treated by either a simple distal anastomosis or the plaque exclusion method, rather endarterectomy is the only revascularization method for these complex vessels.

Erylimaz ET al[14] have reported that at the end of the first year, 100% bypasses to the endarterectomized arteries were patent. The overall angiographic graft patency rate of all grafts applied was 95.6%. They reported off pump coronary endarterectomy on 11 patients who had unstable angina pectoris. Off pump open LAD endarterectomy was done in 7 patients and closed endarterectomy of the RCA was done on the remaining 4 patients. All patients were completely revascularized, LIMA was applied to LAD in all patients and all other grafts were of saphenous vein grafts. At the end of first year 9 patients were NYHA Class I or II and all were angina free.

Marinelli et al[20] have reported 30.4 month angiographic patency rate of 72% of the endarterectomized coronary arteries, while the patency rate of non-endarterectomized arteries was not significantly different at 73%±12%. According to the endarterectomized arteries and bypass grafts used, the patency rate was 75% for the LAD (LIMA graft), 90% for the RCA (SVGs), 80% for the PDA, 60% for the OM and 55% for diagonal artery. 107 patients underwent myocardial revascularization with coronary endarterectomy. The most frequently endarterectomized vessel was the left coronary artery (74.8%). There were 5(4.7%) early deaths, while 72 months survival was 91.2%±4.9%. Seventy seven (83.7%) of the survivors were symptom free and 15(16.3%) were in Canadian Cardiovascular Society Class II to III.

Santini ET al[23] have reported an angiographic fully patent LAD graft in 82% of the cases versus occluded grafts in the remaining 18%. 83% patients underwent extensive reconstruction of the LAD by an autologous vein patch, with or without endarterectomy, associated with LIMA grafting on to the patch. There was one hospital death while 7(80%) patients had a perioperative myocardial infarction. There were 5(6%) late cardiac deaths. A total of 74% survivors had no symptoms. 12% were in Canadian Cardiovascular Society Class I-II and 14% in Class III-IV. Santini et al have studied only LAD while we studied all arteries.

In the current study we included patients before discharge so perioperative myocardial infarction was not studied. However one of our patients presented in the first month postoperatively with acute myocardial infarction and was poorly compliant to medication. Myocardial infarction secondary to acute graft closure is a major complication after coronary endarterectomy with a reported incidence of 1.5-19%.[1, 8, 25-26]

Vohra ET al[24] have reported 4.3% incidence of post-

operative myocardial infarction. They studied 70 patients undergoing off pump coronary endarterectomy. They observed a higher incidence of myocardial infarction around day 3 or 4 after the operation. The median follow-up in their study was 4.91 years, 90% of patients were angina free and the actuarial survival at 10 years was 70.04±7.6%, the 30 days mortality rate being 2.85%. In our study at the end of 1 year of follow-up mortality was zero and angina occurred in 8(10.1%) patients.

Nurozler ET al[25] have reported a perioperative myocardial infarction rate of 6.2%, the overall mortality in their study was 3.1% at the end of a follow-up period of 14±3.3 months.

In both of these studies, off-pump coronary endarterectomy was performed and majority had single vessel coronary endarterectomies to RCA, while we used off pump technique in only 48(64%) patients and two vessel endarterectomy was done in 10 patients (10.34%).Most of the symptoms occurred in patients with multiple endarterectomies. Primarily these were the patients who had severe diffuse disease with symptoms refractory to medical therapy and multiple endarterectomies were performed as a last resort.

CONCLUSION

Coronary endarterectomy with coronary artery bypass grafting has favorable outcome. The angiographic graft patency rate of endarterectomized vessels and their associated grafts is similar to non endarterectomized vessels. For patients with refractory angina and severe diffuse disease, coronary endarterectomy is a suitable surgical option.

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