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OUTCOME AFTER CORONARY ARTERY BYPASS GRAFTING IN CORONARY ARTERY DISEASE WITH LEFT VENTRICULAR SYSTOLIC DYSFUNCTION

Cardiology

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KEYWORDS

INTRODUCTION

Coronary artery bypass grafting (CABG) is one of the most important surgical procedures in the history of medicine. It has been the most common adult cardiac surgical procedure, but its future is increasingly threatened by percutaneous alternative procedures. However, CABG is evolving and remains the most durable means of revascularization for coronary artery disease. It prolongs lives and provides more symptomatic relief. The incidence of coronary artery disease (CAD) has increased in developing countries. Despite improvements in medical therapies and surgical techniques, the management of patients with coronary artery disease and low ejection fraction (EF) is still challenging. Current treatment options for this cohort include intensive medical therapy, surgical revascularization, ventricular remodelling, and heart transplantation. The left ventricular systolic dysfunction (LVD) after myocardial infarction may be reversible as in myocardial hibernation or irreversible related to scar. Surgical revascularization in patients with left ventricular dysfunction does provide a long term survival benefit when compared to medical therapy. Clinicians are often faced with a difficult decision of whether to recommend revascularization in these patients to improve symptoms, left ventricle function and prognosis. Revascularization, either percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) is required in a large number of these patients. Operative risks are high in patients with left ventricular dysfunction compared to those without dysfunction. Outcomes of surgery may depend on the amount of viable myocardium. Despite improvements in surgical techniques, myocardial protection and postoperative care, the surgical risk remains high. From the available data, it has been proved that coronary artery bypass grafting gives better results in diabetic, left ventricular dysfunction and severe coronary artery disease patients.

AIMS AND OBJECTIVES

AIMS

To study the improvement in left ventricular systolic dysfunction in coronary artery disease patients after coronary artery bypass grafting.

OBJECTIVES

1. To find out in patients having coronary artery disease with left ventricular dysfunction (<50%) Whether there is any improvement in the ejection fraction after revascularization by coronary artery bypass grafting after 6 months of operation and if so, to quantify this improvement.

2. To study the improvement in symptomatology and regression of cardiomegaly as complementary parameters for improvement in left ventricular dysfunction.

MATERIALS AND METHODS

The records of all patients who underwent coronary artery bypass grafting at our institution between January 2009 and June 2012 were retrieved. From this group, all patients who had left ventricular dysfunction were selected and their records studied. Excluding the patients who were lost to follow up or for whom proper records were unavailable, details of 117 patients were collected from both inpatient and outpatient records and reviewed. The clinical features, preoperative risk factors, chest x ray, electrocardiogram, echocardiogram, angiogram findings, details of surgery performed and postoperative follow up at 6 months which included details of clinical features, chest x ray and echocardiogram were analysed.

Statistical analysis of the data was performed using the paired T test, McNemar T test, frequency and percentages. All p-values were two tailed and a value of less than 0.05 was considered significant.

Surgical technique:

All patients received prophylactic antibiotics of Inj. Cefuroxime 25 mg/kg and Inj. Amikacin 10 mg/kg at the time of induction and followed by Inj. Cefuroxime twice daily and Amikacin once daily for 3 days. In patients with renal dysfunction, we use Inj. Ceftazidime 25 mg/kg and Inj. Augmentin 25 mg/kg at the time of induction and thrice daily for 3 days. After that they received oral antibiotics for the next 2 days.

After chest opening by a median sternotomy, the thymus was divided and the pericardium opened. The ventricular status and contractility were assessed. The left anterior descending artery inspected and the left internal mammary artery was harvestedin all feasible cases. Simultaneously the great saphenous vein was harvested. After heparinisation to bring the ACT to 480 sec, aortic and single two stage venous cannulations were done and cardiopulmonary bypass was established. Target vessels were inspected and marked. The Aorta was cross clamped and the heart was arrested using cold blood cardioplegia. The patient was cooled to 32 c. Distal coronary anastomoses were performed using 8/0 prolene suture and rewarming was begun at the completion of the last anastomosis. The cross clamp was released with root on suction. The proximal anastomoses were done using 6/0 prolene with side biting clamp. Left atrial line and temporary epicardial pacing wires were taken if necessary. After coming off bypass, cannulae were removed in stages and complete haemostasis was obtained. Pericardial and mediastinal drains were inserted. Left pleural drain for those who had left internal mammary artery harvested was inserted. Sternum was closed with stainless steel wires followed by standard wound closure. The patient was transferred to the ICU with the endotracheal tube insitu.

Postoperative management:

Patients were ventilated in the synchronous intermittent mandatory ventilation mode with tidal volume of 8 to 10 ml/kg and sedated with continous morphine infusion or intermittent boluses of the same. If required, the patient was paralysed with Vecuronium. Haemoglobin, electrolytes, cardiac enzymes, arterial blood gases, an electrocardiogram and chest Xray were routinely performed. Inotropic supports were adjusted according to the hemodynamic status of the patient. They were extubated in the morning of the day after surgery if they were hemodynamicaly stable with minimal inotropic supports and neurologically alright. A chest X ray and electrocardiogram were done on the fifthpostoperative day. They were discharged on the seventh or eighth postoperative day if the recovery was uneventful.

Follow up:

Retrospective analysis of the hospital records were used to study the follow up data of the coronary artery disease patients with left ventricular dysfunction. Ejection fraction improvement in echocardiography, regression in left ventricular enlargement in the chest X ray and symptomatic improvement were studied.

RESULTS

Sex distribution

This study included total of 117 patients who had coronary artery disease with left ventricular dysfunction. There were 8 females and 109 males in this study. The males constituted 93.2% and females 6.8%.

Table 1: Sex distribution of the study group

Variables : Sex	N	%
Male	109	93.2
Female	8	6.8

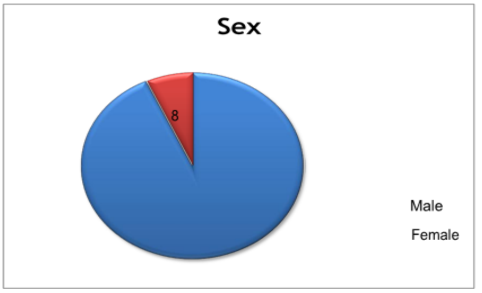

Fig.1 - Pie chart showing sex distribution of the study group Age distribution:

The mean age was 57 years and ranged from 35 to 82 years. Most of the study population were in the sixth decade, they constitute 44.4%. The patients between 61 to 70 years were 28.2%, 40 to 50 years 17.1%, older than 70 years 8.5% and below 40 years only 1.7%.

Variables: Age (Years)	N	%
< 40	2	1.7
41 – 50	20	17.1
51 – 60	52	44.4
61 – 70	33	28.2
> 70	10	8.5

Table 2: Age distribution of the study group

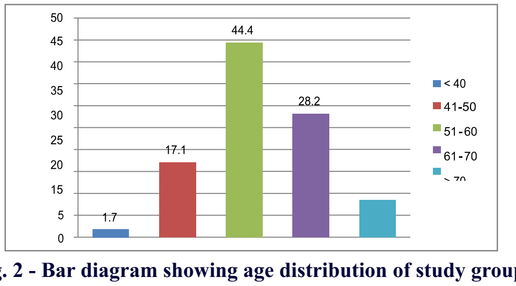

Fig. 2 - Bar diagram showing age distribution of study group. Dyspnoea on exertion

About 43.6% of patients with left ventricular dysfunction presented with history of dyspnoea on exertion, almost all of them were in NYHA CLASS II. The remaining 56.4% were free of dyspnoea on presentation.

Table 3: Patients who presented with dyspnoea on exertion (DOE).

Variables : DOE	N	%
Yes	51	43.6
No	66	56.4

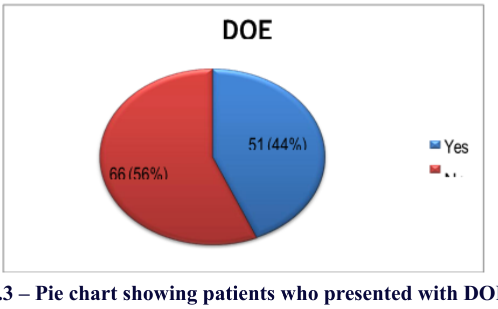

Fig.3 – Pie chart showing patients who presented with DOE. Left ventricular enlargement in Chest Xray:

36 patients in this study had cardiomegaly with left ventricular enlargement in the chest x ray, which forms 30.8%.

Table 4: Patients with left ventricular enlargement on Chest xray.

Variables : Chest X-Ray	N	%
LV Enlargement	36	30.8
Normal	81	69.2

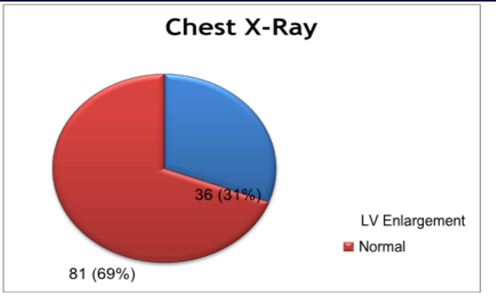

Fig. 4 – Pie chart showing patients with LV enlargement in Chest xray.

ECG changes

The most common ECG findings were inferior wall MI, which constituted 25.6%, anterior wall MI (15.4%) and lateral wall ischemic changes (12%). Other less common findings are lateral wall MI, anterior wall, inferior wall, anterolateral and anteroseptal ischemic changes. There were 17.1% of patients without any changes in the electrocardiogram.

Table 5: Various ECG changes in the study group

Variables : ECG	n	%
AW MI	18	15.4
LW MI	3	2.6
IW MI	30	25.6
AW Ischemia	3	2.6
LW Ischemia	14	12.0
IW Ischemia	7	6.0
AL Ischemia	10	8.5
AS Ischemia	6	5.1
Normal	20	17.1
AL MI	4	3.4
LVH	2	1.7

AWMI-anterior wall myocardial infarction, LWMI-lateral wall myocardial infarction, IWMI-inferior wall myocardial infarction, AL-anterolateral , AS- anteroseptal, LVH- left ventricular hypertrophy.

Coronary Angiogram (CAG):

On analysing the coronary angiographic findings, the triple vessel disease patients formed the bulk of the study. They were totally 91 (77.8%) which includes 11 patients with left main equivalent and 16 patients with left main coronary involvement.

Table 6: Coronary angiogram findings of the study group.

Variables	N	%
SVD	2	1.7
DVD	20	17.1
TVD	64	54.7
LMD	3	2.6
LME	1	0.9
TVD with LMD	16	13.7
TVD with LME	11	9.4

SVD – single vessel disease, DVD – double vessel disease, TVD – triple vessel disease, LMD – left main disease, LME – left main equivalent, TVD with LMD – triple vessel disease with left main disease, TVD with LME– triple vessel disease with left main equivalent.

ECHO

Almost all patients had regional wall motion abnormality, 95.7% (112 of 117) patients presented with wall motion abnormality. Only 4.3% showed no regional wall motion abnormality.

Table 7: Echocardiogram finding of regional wall motion abnormality (RWMA)

Variables : Echo (RWMA)	N	%
Present	112	95.7
Absent	5	4.3

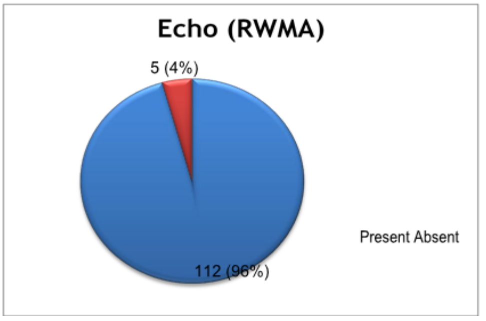

Fig. 5 –Pie chart showing echocardiographic regional wall motion abnormalities

About 23% of this study group had ejection fraction between 30 to 40% and 76% had above 40%. But only 1% was below 30% ejection fraction.

Table 8: Preoperative echocardiogram ejection fraction (EF)distribution.

Variables : ECHO (preop EF %)	N	%
≤ 30	1	0.9
31 – 40	27	23.1
≥ 40	89	76.1

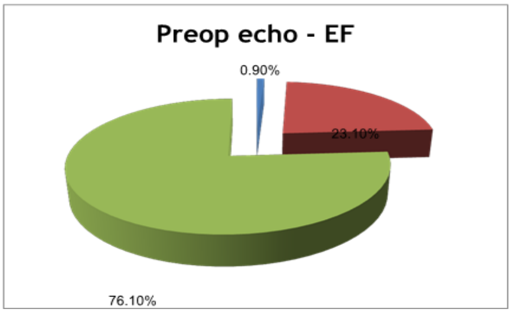

Fig. 6 – Pie chart showing preoperative EF distribution

COMORBIDITIES

In this study 73.5% of patients had associated comorbidities which includes 33.3% of hypertension, 11.1% of diabetes mellitus and 29.1% of both comorbidities. The patients without any comorbid illnesses were 26.5%.

Table 9: Comorbidities distribution of the study group. HT – hypertension, DM – diabetes mellitus.

Variables : Comorbidities	N	%
None	31	26.5
HT	39	33.3
DM	13	11.1
HT & DM	34	29.1

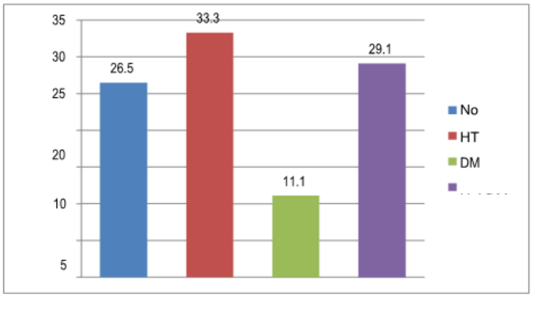

Fig. 7 – Bar diagram showing comorbidities distribution of the study group

NUMBER OF GRAFTS

The number of grafts were decided based on angiogram and on table findings. Most of the patients (42.7%) received three grafts, which includes left internal mammary artery to left anterior descending artery. All three vein grafts were used in 31.6%. Eleven (9.5%) patients received four grafts, including 8 who had one LIMA and three veins and one patient who had LIMA , radial artery and two vein grafts.

Table 10: Number of grafts done.

Variables : Number of grafts	n	%
1L, 2V	50	42.7
3V	37	31.6
1L, 3V	8	6.8
4V	2	1.7
2V	6	5.1
IL, IV	11	9.4
2A, 2V	1	0.9
1L	2	1.7

1L,2V – one LIMA and two vein grafts, 3V – three vein grafts, 1L,3V – one LIMA and three vein grafts, 4V – four vein grafts, 2V – two vein grafts, 1L,1V – one LIMA and one vein graft, 2A,2V – one LIMA, one radial artery and two vein grafts, 1L – one LIMA only.

POSTOPERATIVE EJECTION FRACTION IMPROVEMENT:

GENERAL:

Among the total 117 patients studied, 84 had postoperative improvement in the EF and 33 patients had no improvement in EF.

Table 11: Postoperative improvement in EF observed in the study group

Variable – postop EF	No.	Percentage
Improvement	84	71.8 %
No improvement	33	28.2 %
Total	117	100 %

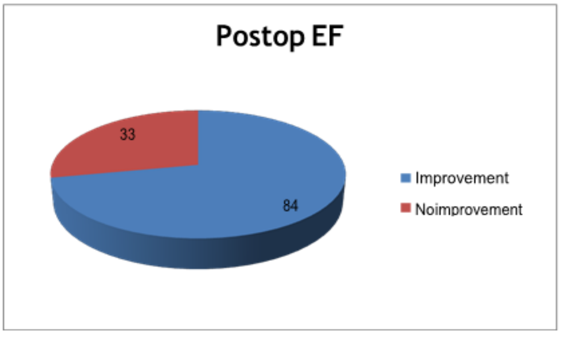

Fig. 8 – Pie chart showing number of patients who had postoperative improvement in EF.

The study population's ejection fractions varied from 29% to 49% with mean of 42.72%. This had improved to mean of 46.78 %, ranging from 34% to 59% after the coronary artery bypass graftings. This improvement is statistically proved as significant.

Table 12: Postoperative EF improvement compared with preoperative EF.

Variables	N	Mean	SD	Minimum	Maximum
ECHO_preop EF	117	42.72	3.84	29	49
ECHO_postop EF	117	46.78	6.42	34	59

Table 13: Statistical significance of postoperative EF improvement

Variables	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	117	42.72 (3.84)	0.469	0.000
ECHO_postop EF	117	46.78 (6.42)		

Table 14: Statistical significance of postoperative EF improvement within preoperative EF groups.

Variables(EF%)	n	Mean (SD)	't' Value	95% CI	p- Value
31 – 40	27	42.52 (5.24)	-4.234	-8.211 to -	0.000
≥ 40	89	48.11 (48.11)			

Note: the statistical significance was not calculated for EF < 30%, as there was only one.

Table 15: Mean postoperative EF for each preoperative EF group.

Age:

Variables : ECHO (preop EF %)	n	Mean	SD
≤ 30	1	43.00	- 5.24
31 – 40	27	42.52	6.22
≥ 40	89	48.11	

Table 16: Mean postoperative EF in each age group.

Variables : Age (Years)	n	Mean	SD
< 40	2	54.50	4.95
41 – 50	20	47.20	7.62
51 – 60	52	46.50	6.19
61 – 70	33	46.27	6.03
> 70	10	47.50	6.67

Table 17: Statistical correlation of postoperative EF improvement in 41 – 50 years.

41 - 50 Years	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	20	42.30 (4.32)	0.497	0.026
ECHO_postop EF		47.20 (7.62)		

Note: Statistical correlation for age group <40 years could not be calculated, as the number of patients were only two.

Table 18: Statistical correlation of postoperative EF improvement in 51 – 60 years.

51 - 60 Years	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	52	42.69 (4.11)	0.457	0.001
ECHO_postop EF		46.50 (6.19)		

Table 19: Statistical correlation of postoperative EF improvement in 61 – 70 years.

61 - 70 Years	N	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	33	42.67 (3.33)	0.457	0.007
ECHO_postop EF		46.27 (6.03)		

Table 20: Statistical correlation of postoperative EF improvement in >70 years.

> 70 Years	N	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	10	43.40 (3.57)	0.486	0.155
ECHO_postop EF		47.50 (6.67)		

Table 21:The statistical significance of mean EF within each age groups of the study population.

ECHO_preop EF – Echo_postop EF	n	Mean Diff (SD)	't' Value	95% CI	p- Value
< 40 Years	2	-9.50 (4.95)	-2.714	-53.97 to 34.97	0.225
41 – 50 Years	20	-4.90 (6.63)	-3.304	-8.00 to - 1.80	0.004
51 – 60 Years	52	-3.81 (5.65)	-4.860	-5.38 to - 2.24	0.000
61 – 70 Years	33	-3.61 (5.40)	-3.839	-5.52 to - 1.69	0.001
> 70 Years	10	-4.10 (5.84)	-2.220	-8.28 to 0.077	0.054

COMORBIDITY

There were significant improvement in the ejection fraction of each group, but there were no statistically significant improvement in between HT, DM and HT &DM groups.

Table 22: Mean postoperative EF in the groups based on comorbidities. HT – hypertension, DM – diabetes mellitus.

Variables : Comorbidities	N	Mean	SD
None	31	48.16	6.49
HT	39	46.54	5.91
DM	13	46.38	5.17
HT & DM	34	45.94	7.35

Table 23: Statistical significance of postoperative EF improvement in patients without Co-morbidities.

None	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	31	43.26	0.537	0.002
ECHO_postop EF		48.16		

Table 24: Statistical significance of postoperative EF improvement in patients with HT.

HT	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	39	42.67 (3.35)	0.193	0.240
ECHO_postop EF		46.54 (5.91)		

Table 25: Statistical significance of postoperative EF improvement in patients with DM.

DM	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop EF	13	42.69 (2.69)	0.429	0.144
ECHO_postop EF		46.38 (5.17)		

Table 26: Statistical significance of postoperative EF improvement in patients with HT & DM

HT & DM	n	Mean (SD)	Correlation 'r'	p- Value
ECHO_preop ef	34	42.29 (4.76)	0.599	0.000
ECHO_postop ef		45.94 (7.35)		

Table 27: Statistical significance of postoperative EF improvement for groups based on Co-morbidities.

ECHO_preopef – Echo_postop ef	N	Mean Diff (SD)	't' Value	95% CI	p- Value
None	31	-4.903 (5.49)	-4.977	-6.915 to - 2.891	0.000
HT	39	-3.872 (6.21)	-3.895	-5.884 to - 1.859	0.000
DM	13	-3.692 (4.70)	-2.834	-6.531 to - 0.854	0.015
HT & DM	34	-3.647 (5.90)	-3.606	-5.705 to - 1.589	0.001

NUMBER OF GRAFTS

The patients who had a LIMA and two vein grafts, all three vein grafts and one LIMA and one vein grafts, showed statistically significant improvement in ejection fraction comparing to patients who had other grafts.

Table 28:Mean postoperative EF in various groups based on the number of grafts.

Variables : Number of grafts	n		%
1L, 2V	50	46.40	6.71
3V	37	46.38	6.32
1L, 3V	8	47.88	3.27
4V	2	47.50	6.36
2V	6	46.50	9.57
IL, IV	11	47.91	6.47
2A, 2V	1	45.00	-

SYMPTOMATIC IMPROVEMENT:

33 patients out of 48(68.8%) had symptomatic improvement after coronary artery bypass grafting.

Table 29: Postoperative improvement in dyspnoea.

Variables :DOE Improvement	n	%
Yes	33	68.8
No	15	31.2

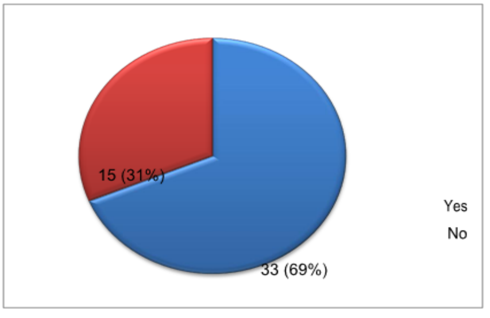

Fig.9 – Pie chart showing postoperative improvement of dyspnoea

REGRESSION IN LEFT VENTRICULAR ENLARGEMENT IN THE CHEST X- RAY:

Thirty one percentage of patients who had had cardiomagaly in the chest xray, 57.1% of them showed regression of left ventricular enlargement postoperatively.

Table 30: Postoperative regression in LV enlargement(normal) and non regression of LV enlargement (LV enlargement).

Variables	Normal		LV enlargement	
	n	%	n	%
Postop CxR	18	52.9	16	47.1

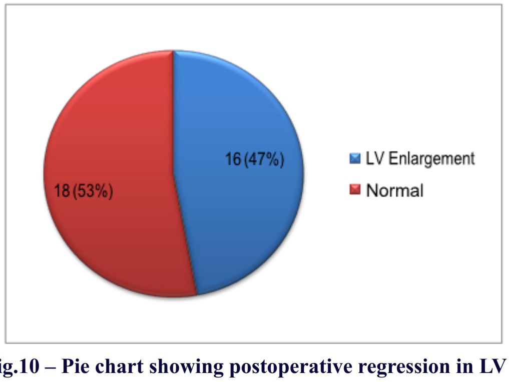

Fig.10 – Pie chart showing postoperative regression in LV enlargement(normal) and non regression of LV enlargement (LV enlargement).

DISCUSSION

Patients with CAD and left ventricular dysfunction have poor prognosis with medical treatment alone despite recent advances. The Coronary Artery Surgery Study (CASS) study demonstrated that only 38% of medically treated patients (EF less than 35%) were alive 5 years after the onset of treatment[113]. Surgical options for coronary artery disease patients with left ventricular dysfunction include CABG, ventricular reconstruction, and cardiac transplantation. Luciani et al[114] reported an 82% 5-year actuarial post transplant survival rate in patients with ischemic heart disease and left ventricular dysfunction , particularly EF of less than 30%. However, organ shortage remains a long-standing problem, and only a small proportion of CAD patients with low EF can benefit from cardiac transplantation. Studies evaluating ventricular reconstruction are currently underway, and this option may become an attractive alternative treatment in the near future[115]. CABG in CAD with left ventricular dysfunction patients has been proved to be superior to medical treatment by several authors. Alderman et al[113] showed that patients with an EF less than 35% who were on medical management had a 43% 5-year survival rate compared with a 63% 5-year survival in the surgically treated patients. Passamani et al[116] showed that 84% of patients who underwent coronary artery bypass grafting for coronary artery disease with ejection fraction less than 50% were alive at 7 years, whereas only 70% of medically treated patients were alive. Di Carli et al,[117] observed a significant decrease in anginal symptoms after CABG compared to medically managed patients. Eventhough CABG provides superior benefits in survival and quality of life over medical treatment, outcomes of left ventricular dysfunction patients are worser than patients with normal left ventricular function. The New York State database, showed anearly mortality of patients with EF less than 20% to be 4 times higher than patients with EF more than 40% (4.6% versus 1.0%).

Our study was done to find out in patients having coronary artery disease with left ventricular dysfunction (<50%) whether there was any improvement in the ejection fraction after revascularization by coronary artery bypass grafting after 6 months of operation. The details of 117 patients who underwent coronary artery bypass grafts for coronary artery disease with left ventricular dysfunction during January 2009 to june 2012 were collected. The echocardiographic ejection fraction, cardiomegaly in the chest xray and clinical symptoms were collected in the preoperative period and after 6 months of the procedure. Most of the study population were males constituting 93%. This might be due to high prevalence of risk factors in the males. The patients with lower ejection fraction had dyspnoea on admission. About 43.6% had this symptom in our study. On review of investigations, 30% of patients showed left ventricular enlargement in the chest xray. After coronary artery bypass grafting, 72% of the study population showed improvement in the ejection fraction, symptomatic improvement in 69% and regression in cardiomegaly in 57%. The common electrocardiographic findings in our study group were inferior and anterior wall myocardial infarction. When the infarction heals, it would form scar which may contain variable amount of viable myocardium scattered within it. So immediate improvement in ejection fraction may be minimal after revascularisation. But ischemic hibernating myocardium will show very good results, dramatic improvement in ejection fraction after revascularisation. As many of our study patients had infarction on electrocardiogram, ejection fraction improvement was only 4% of mean. The preoperative echocardiogram showed regional wall motion abnormality in 95.7% and ejection fraction varied from 29 to 49% with mean of 42.7%. The postoperative echocardiogram at 6 months after revascularisation showed a statisticallysignificant improvement in ejection fraction with mean EF of 46.7% and ranged between 34 to 59%. This is an immediate improvement in the myocardial contractility. As time progresses more viable myocardial foci in the scar tissue will be recruited and improve contractility, thus will improve regional wall motion abnormalities. Surgical revascularisation was done using arterial and venous conduits. Most of them received three grafts, including one left internal mammary artery(LIMA). Those who had poor contractility, diffusely diseased left anterior descending artery and stuck LIMA did not have a LIMA graft. Instead they received all three saphenous vein grafts. There was significant improvement in ejection fraction of each group who received two, three and four grafts irrespective of whether arterial graft was used or not. But in between groups, the patients who received three or four vein grafts and a LIMA with two vein grafts had statistically significant improvement in ejection fraction postoperatively. This could possibly be because flows in the venous conduits are good in the initial postoperative period, whereas LIMA grafts last longer, thus giving long term survival benefits. The comorbidities like HT, DM or both were present in 73.5% of the patients. The improvement in EF was significant in each comorbid illness, but no significant difference was noted in between them.

This study showed significant improvement in the ejection fraction 6 months after revascularisation in coronary artery disease patients with left ventricular dysfunction. This trend may continue up to 2 years to give maximum increase in EF. But the mean EF of 4% increase over the preoperative EF seems to be less than the previous study results which showed 10 to 15% improvement [131]. This may be explained by different population group with variable hibernating myocardium. The patients with scattered viable myocytes in the scarred myocardium may show later improvement in the left ventricularfunction. The improved left ventricular dysfunction manifested as betterment of symptoms postoperatively and regression of cardiomegaly in the chest Xray.

LIMITATIONS OF THE STUDY

This is a retrospective study. Those patients who underwent concomitant procedures were excluded from this study to avoid the confounding factors. Considering cost effectivenss of the Sestamibi scan, it could not be used as a preoperative and postoperative left ventricular function assessement tool. We did not look into and study the few patients who had a worsening of their ejection fraction postoperatively. These patients probably had large myocardial scars or diffusely diseased vessels preventing complete revascularisation.

CONCLUSION

From our study we conclude that surgical revascularisation in coronary artery disease with left ventricular dysfunction provides superior benefits in improving ejection fraction and quality of life despite the increased morbidity and mortality when compared to patients with normal left ventricular function. The improvement in the ejection fractions were accompanied by symptomatic improvement and also regression in cardiomegaly.

Patients with left ventricular dysfunction can benefit from coronary artery bypass grafting by improved left ventricular contractility as documented by significant increase in ejection fraction. Successful CABG is associated with increased survival rate and improved New York Heart Association functional class[118]. CABG can be performed on the severely dyskinetic ventricle with long term improvement in EF and functional status. The reason for this improvement appears to be improvement in the systolic left ventricular dimensions in the first 6 months after operation with improving trends up to 2 years. Chronic ischemic cardiomyopathy causes the left ventricle to dilate along the short axis, giving a more spherical shape with decreased contractility [119]. Patients with a significant amount of hibernating myocardium or reversible ventricular dysfunction have demonstrated immediate improvement in LV function as early as 6 to 48 hours after revascularization [120]. This will explain the most dramatic change in EF that occur in the first 6 months after operation. It is difficult to predict which patients will show a response after revascularization. Investigations to find out hibernating myocardium using stress dobutamine echocardiography, positron emission tomography or thallium scintigraphy were not definite [121]. Reversible defects on these imagings do not always recover contractility after revascularisation. Some investigators do not routinely use theseinvestigations to predict whom should receive revascularisation[122]. Most patients with chronic stable, unstable or postinfarction angina with graftable distal targets had undergone CABG. They had shown improved LV function after CABG.

REFERENCES

1. Vineberg A, Miller G. Internal mammary coronary anastomosis in the surgical treatment of coronary artery insufficiency. Can Med Assoc J 1951;64:204.
2. Murray G, Porcheron R, Hilario J, Roschlau W. Anastomosis of a systemic artery to the coronary. Can Med Assoc J 1954;71:594.
3. Longmire WP Jr, Cannon JA, Kattus AA. Direct-vision coronary endarterectomy for angina pectoris. N Engl J Med 1958;259:993.
4. Senning A. Strip grafting in coronary arteries: report of a case. J Thorac Cardiovasc Surg 1961;41:542.
5. Favaloro RG. Saphenous vein graft in the surgical treatment of coronary artery disease: operative technique. J Thorac Cardiovasc Surg 1969;58:178.
6. Kolessov VI. Mammary artery-coronary artery anastomosis as method of treatment for angina pectoris. J Thorac Cardiovasc Surg 1967;54:535.
7. Flemma RJ, Johnson WD, Lepley D Jr. Triple aorto-coronary vein bypass as treatment for coronary insufficiency. Arch Surg 1971;103:82.
8. Shub C, Vlietstra RE, Smith HC, Fulton RE, Elveback LR. The unpredictable progression of symptomatic coronary artery disease: a serial clinical-angiographic analysis. Mayo Clin Proc 1981;56:155.
9. Baughman KL, Maroko PR, Vatner SF. Effects of coronary artery reperfusion on myocardial infarct size and survival in conscious dogs. Circulation 1981;63:317.
10. Moise A, Lesperance J, Theroux P, Taeymans Y, Goulet C, Bourassa MG. Clinical and angiographic predictors of new total coronary occlusion in coronary artery disease: analysis of 313 nonoperated patients. Am J Cardiol 1984;54:1176.
11. Friesinger GC, Page EE, Ross RS. Prognostic significance of coronary arteriography. Trans Assoc Am Physicians 1970;83:78.
12. Bruschke AV, Wijers TS, Kolsters W, Landmann J. The anatomic evolution of coronary artery disease demonstrated by coronary arteriography in 256 nonoperated patients. Circulation 1981;63:527.
13. Bemis CE, Gorlin R, Kemp HG, Herman MV. Progression of coronary artery disease: a clinical arteriographic study. Circulation 1973;47:455.
14. Blackstone EH, Takaro T, Hultgren H, Peduzzi P, Detre K, Kirklin JW. Unpublished study, 1990.
15. See JR, Cohn PF, Holman BL, Roberts BH, Adams DF. Angiographic abnormalities associated with alterations in regional myocardial blood flow in coronary artery disease. Br Heart J 1976;38:1278.
16. Bruce RA, DeRouen TA, Hammermeister KE. Noninvasive screening criteria for enhanced 4-year survival after aortocoronary bypass surgery. Circulation 1979;60:638.
17. Bonow RO, Vitale DF, Bacharach SL, Frederick TM, Kent KM, Green MV. Asynchronous left ventricular regional function and impaired global diastolic filling in patients with coronary artery disease:reversal after coronary angioplasty. Circulation 1985;71:297
18. Borer JS, Rosing DR, Miller RH, Stark RM, Kent KM, Bacharach SL, et al. Natural history of left ventricular function during 1 year after acute myocardial infarction: comparison with clinical, electrocardiographic and biochemical determinations. Am J Cardiol 1980;46:1.
19. Bigger JT, Heller CA, Wenger TL, Weld FM. Risk stratification after acute myocardial infarction. Am J Cardiol 1978;42:202.
20. Califf RM, Tomabechi Y, Lee KL, Phillips H, Pryor DB, Harrell FE Jr, et al. Outcome in one-vessel coronary artery disease. Circulation 1983;67:283.
21. Myers WO, Schaff HV, Gersh BJ, Fisher LD, Kosinski AS, Mock MB, et al. Improved survival of surgically treated patients with triple vessel coronary artery disease and severe angina pectoris. A report from the Coronary Artery Surgery Study (CASS) Registry. J Thorac Cardiovasc Surg 1989;97:487.
22. Kouchoukos NT, Blackstone EH, Doty DB, Henley FL, Karp RB, et al. Stenotic atherosclerotic coronary artery disease. Text book of cardiac surgery Kirklin/Barratt-Boyes. Third ed.: pg 360 -364, 395 – 398,400 – 401,
23. Myers WO, Schaff HV, Gersh BJ, Fisher LD, Kosinski AS, Mock MB, et al. Improved survival of surgically treated patients with triple vessel coronary artery disease and severe angina pectoris. A report from the Coronary Artery Surgery Study (CASS) Registry. J Thorac Cardiovasc Surg 1989;97:487.
24. LaCroix AZ, Guralnik JM, Curb JD, Wallace RB, Ostfeld AM, Hennekens CH. Chest pain and coronary heart disease mortality among older men and women in three communities. Circulation 1990:81:437
25. Katariya K, DeMarchena E, Bolooki H. Oral amiodarone reduces incidence of postoperative atrial fibrillation. Ann Thorac Surg 1999;68:1599.
26. Buda AJ, Macdonald IL, Anderson MJ, Strauss HD, David TE, Berman ND. Long- term results following coronary bypass operation: importance of preoperative factors and complete revascularization. J Thorac Cardiovasc Surg 1981;82:383.
27. Barzilai B, Marshall WG Jr, Saffitz JE, Kouchoukos N. Avoidance of embolic complications by ultrasonic characterization of the ascending aorta. Circulation 1989;80:I275.
28. Ricci M, Karamanoukian HL, D'Ancona G, Bergsland J, Salerno TA. Exposure and mechanical stabilization in off-pump coronary artery bypass grafting via sternotomy. Ann Thorac Surg 2000;70:1736.
29. Puskas JD, Vinten-Johansen J, Muraki S, Guyton RA. Myocardial protection for off-pump coronary artery bypass surgery. Semin Thorac Cardiovasc Surg 2001;13:82.
30. Allen KB, Griffith GL, Heimansohn DA, Robison RJ, Matheny RG, Schier JJ, et al. Endoscopic versus traditional saphenous vein harvesting:a prospective, randomized trial. Ann Thorac Surg 1998;66:26.
31. Catinella FP, Cunningham JN Jr, Srungaram RK, Baumann FG, Nathan IM, Glassman EA, et al. The factors influencing early patency of coronary artery bypass vein grafts: correlation of angiographic and ultrastructural findings. J Thorac Cardiovasc Surg 1982;83:686.
32. Grow JB Sr, Brantigan CO. The diamond anastomosis: a technique for creating a right angle side-to-side vascular anastomosis. J Thorac Cardiovasc Surg 1975;69:188.
33. Goldman S, Copeland J, Moritz T, Henderson W, Zadina K, Ovitt T, et al. Saphenous vein graft patency 1 year after coronary artery bypass surgery and effects of antiplatelet therapy. Results of a Veterans Administration Cooperative Study. Circulation 1989;80:1190.
34. Goldman S, Copeland J, Moritz T, Henderson W, Zadina K, Ovitt T, et al. Improvement in early saphenous vein graft patency after coronary artery bypass surgerywith antiplatelet therapy: results of a Veterans Administration Cooperative Study. Circulation 1988;77:1324.
35. Williams JB, Stephenson LW, Holford FD, Langer T, Dunkman WB, Josephson ME. Arrhythmia prophylaxis using propranolol after coronary artery surgery. Ann Thorac Surg 1982;34:435
36. Fuller JA, Adams GG, Buxton B. Atrial fibrillation after coronary artery bypass grafting. Is it a disorder of the elderly? J Thorac Cardiovasc Surg 1989;97:821
37. Fan K, Lee KL, Chiu CS, Lee JW, He GW, Cheung D, et al. Effects of biatrial pacing in prevention of postoperative atrial fibrillation after coronary artery bypass surgery. Circulation 2000; 102:755.
38. Daoud EG, Dabir R, Archambeau M, Morady F, Strickberger SA. Randomized, double-blind trial of simultaneous right and left atrial epicardial pacing for prevention of post-open heart surgery atrial fibrillation. Circulation 2000;102:761.
39. Pfisterer M, Burkart F, Jockers G, Meyer B, Regenass S, Burckhardt D, et al. Trial of low-dose aspirin plus dipyridamole versus anticoagulants for prevention of aortocoronary vein graft occlusion. Lancet 1989;2:1.
40. Goldman S, Copeland J, Moritz T, Henderson W, Zadina K, Ovitt T, et al. Starting aspirin therapy after operation. Effects on early graft patency. Department of Veterans Affairs Cooperative Study Group. Circulation 1991;84:520.
41. Chaitman BR, Fisher LD, Bourassa MG, Davis K, Rogers WJ, Maynard C, et al. Effect of coronary bypass surgery on survival patterns in subsets of patients with left main coronary artery disease. Am J Cardiol 1981;48:765.
42. Blankenhorn DH, Nessim SA, Johnson RL, Sanmarco ME, Azen SP, Cashin- Hemphill L. Beneficial effects of combined colestipol-niacin therapy on coronary atherosclerosis and coronary venous bypass grafts. JAMA 1987;257:3233
43. ACC/AHA Joint Task Force Subcommittee on Coronary Artery Bypass Graft Surgery. Guidelines and indications for coronary artery bypass graft surgery. Circulation 1991;83:1125. Bryson AL, Parisi AF,
44. Brown G, Albers JJ, Fisher LD, Schaefer SM, Lin JT, Kaplan C, et al. Regression of coronary artery disease as a result of intensive lipidlowering therapy in men with high levels of apolipoprotein B. N Engl J Med 1990;323:1289
45. Hannan EL, Burke J. Effect of age on mortality in coronary artery bypass surgery in New York, 1991-1992. Am Heart J 1994;128:1184.
46. Edwards FH, Carey JS, Grover FL, Bero JW, Hartz RS. Impact of gender on coronary artery bypass operative mortality. Ann Thorac Surg 1998;66:125
47. Eagle KA, Guyton RA, Davidoff R, Ewy GA, Fonger J, Gardner TJ, et al. ACC/AHA Guidelines for Coronary Artery Bypass Graft Surgery: A Report of the American

College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1991 Guidelines for Coronary Artery Bypass Graft Surgery). American College of Cardiology/American Heart Association. J Am Coll Cardiol 1999;34:1262
48. Azariades M, Fessler CL, Floten HS, Starr A. Five-year results of coronary bypass grafting for patients older than 70 years: role of internal mammary artery. Ann Thorac Surg 1990;50:940.
49. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, et al. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. N Engl J Med 1996;335:1857
50. Loop FD, Lytle BW, Cosgrove DM, Mahfood S, McHenry MC, Goormastic M, et al. J. Maxwell Chamberlain memorial paper. Sternal wound complications after isolated coronary artery bypass grafting: early and late mortality, morbidity, and cost of care. Ann Thorac Surg 1990:49:179.
51. Kouchoukos NT, Wareing TH, Murphy SF, Pelate C, Marshall WG Jr. Risks of bilateral internal mammary artery bypass grafting. Ann Thorac Surg 1990;49:210.
52. Bull DA, Neumayer LA, Stringham JC, Meldrum P, Affleck DG, Karwande SV. Coronary artery bypass grafting with cardiopulmonary bypass versus off-pump cardiopulmonary bypass grafting: does eliminating the pump reduce morbidity and cost? Ann Thorac Surg 2001;71:170.
53. Mangano CM, Diamondstone LS, Ramsay JG, Aggarwal A, Herskowitz A, Mangano DT Renal dysfunction after myocardial revascularization: risk factors, adverse outcomes, and hospital resource utilization. Ann Intern Med 1998;128:194.
54. van Dijk D, Nierich AP, Jansen EW, Nathoe HM, Suyker WJ, Diephuis JC, et al. Early outcome after off-pump versus on-pump coronary bypass surgery: results from a randomized study. Circulation 2001;104:1761.
55. Kennedy JW, Ivey TD, Misbach G, Allen MD, Maynard C, Dalquist JE, et al. Coronary artery bypass graft surgery early after acute myocardial infarction. Circulation 1989;79:173.
56. Coles JG, Del Campo C, Ahmed SN, Corpus R, MacDonald AC, Goldbach MM, et al. Improved long-term survival following myocardial revascularization in patients with severe left ventricular dysfunction. J Thorac Cardiovasc Surg 1981;81:846.
57. Wechsler AS, Junod FL. Coronary bypass grafting in patients with chronic congestive heart failure. Circulation 1989;79:I92.
58. Kirklin JW, Naftel CD, Blackstone EH, Pohost GM. Summary of a consensus concerning death and ischemic events after coronary artery bypass grafting. Circulation 1989;79:181.
59. Booth DC, Deupree RH, Hultgren HN, DeMariaAN, Scott SM, Luchi RJ. Quality of life after bypass surgery for unstable angina. 5-year follow-up results of a Veterans Affairs Cooperative Study. Circulation 1991;83:87.
60. Harrison MJ, Schneidau A, Ho R, Smith PL, Newman S, Treasure T. Cerebrovascular disease and functional outcome after coronary artery bypass surgery. Stroke 1989;20:235.
61. Townes BD, Bashein G, Hornbein TF, Coppel DB, Goldstein DE, Davis KB, et al. Neurobehavioral outcomes in cardiac operations. A prospective controlled study. J Thorac Cardiovasc Surg 1989;98:774.
62. Katz ES, Tunick PA, Rusinek H, Ribakove G, Spencer FC, Kronzon I. Protruding aortic atheromas predict stroke in elderly patients undergoing cardiopulmonary bypass: experience with intraoperative transesophageal echocardiography. J Am Coll Cardiol 1992;20:70.
63. Cosgrove DM, Loop FD, Lytle BW, Baillot R, Gill CC, Golding LA, et al. Primary myocardial revascularization. J Thorac Cardiovasc Surg 1984:88:673.
64. Hossack KF, Bruce RA, Ivey TD, Kusumi F, Kannagi T. Improvement in aerobic and hemodynamic responses to exercise following aortacoronary bypass grafting. J Thorac Cardiovasc Surg 1984;87:901.
65. Serruys PW, Rousseau MF, Cosyns J, Ponlot R, Brasseur LA, Detry JM. Hemodynamics during maximal exercise after coronary bypass surgery. Br Heart J 197 ;40:1205
66. Rubenson DS, Tucker CR, London E, Miller DC, Stinson EB, Popp RL. Two-dimensional echocardiographic analysis of segmental left ventricular wall motion before and after coronary artery bypass surgery. Circulation 1982;66:1025.
67. Wainwright RJ, Brennand-Roper DA, Maisey MN, Sowton E. Exercise thallium-201 myocardial scintigraphy in the follow-up of aortocoronary bypass graft surgery. Br Heart J 1980;43:56.
68. Lazar HL, Plehn JF, Schick EM, Dobnick D, Shemin RJ. Effects of coronary revascularization on regional wall motion. J Thorac Cardiovasc Surg 1989:98:498.
69. Mintz LJ, Ingels NB Jr, Daughters GT 2nd, Stinson EB, Alderman EL. Sequential studies of left ventricular function and wall motion after coronary arterial bypass surgery. Am J Cardiol 1980;45:210.
70. Dilsizian V, Bonow RO, Cannon RO, Tracy CM, Vitale DF, Mcintosh CL, et al. The effect of coronary bypass grafting on left ventricular systolic function at rest: evidence for preoperative subclinical myocardial ischemia. Am J Cardiol 1988;61:1248.
71. Bypass Angioplasty Revascularization Investigation (BARI) Investigators. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. N Engl J Med 1996;335:217.
72. Humphrey LS, Topol EJ, Rosenfeld GI, Borkon AM, Baumgartner WA, Gardner TJ, et al. Immediate enhancement of left ventricular relaxation by coronary artery bypass grafting: intraoperative assessment. Circulation 1988;77:886.
73. Hellman CK, Kamath ML, Schmidt DH, Anholm J, Blau F, Johnson WD. Improvement in left ventricular function after myocardial revascularization: assessment by first-pass rest and exercise nuclear angiography. J Thorac Cardiovasc Surg 1980;79:645.
74. Newman GE, Rerych SK, Jones RH, Sabiston DC Jr. Noninvasive assessment of the effects of aorto-coronary bypass grafting on ventricular function during rest and exercise. J Thorac Cardiovasc Surg 1980;79:617.
75. de Soyza N, Murphy ML, Bissett JK, Kane JJ, Doherty JE 3rd. Ventricular arrhythmias in chronic stable angina pectoris with surgical or medical treatment. Ann Intern Med 1978;89:10.
76. McNamara JJ, Bjerke HS, Chung GK, Dang CR. Blood flow in sequential vein grafts. Circulation 1979:60:33.
77. Hamby RI, Aintablian A, Handler M, Voleti C, Weisz D, Garvey JW, et al. Aortocoronary saphenous vein bypass grafts: long-term patency, morphology and blood flow in patients with patent grafts early after surgery. Circulation 1979;60:901.
78. Weisz D, Hamby RI, Aintablian A, Voleti C, Fogel R, Wisoff BG. Late coronary bypass graft flow: quantitative assessment by roentgendensitometry. Ann Thorac Surg 1979;28:429.
79. Azariades M, Fessler CL, Floten HS, Starr A. Five-year results of coronary bypass grafting for patients older than 70 years: role of internal mammary artery. Ann Thorac Surg 1990;50:940.
80. Loop FD, Lytle BW, Cosgrove DM, Golding LA, Taylor PC, Stewart RW. Free (aorta-coronary) internal mammary artery graft. Late results. JThorac Cardiovasc Surg 1986;92:827
81. Luscher TF, Diederich D, Siebenmann R, Lehmann K, Stulz P, von Segesser L, et al. Difference between endothelium-dependent relaxation in arterial and in venous coronary bypass grafts. N Engl J Med 1988;319:462
82. Shelton ME, Forman MB, Virmani R, Bajaj A, Stoney WS, Atkinson JB. A comparison of morphologic and angiographic findings in long-term internal mammary artery and saphenous vein bypass grafts. J Am Coll Cardiol 1988;11:297.
83. Cameron A, Davis KB, Green G, Schaff HV. Coronary bypass surgery with internal-thoracic-artery grafts—effects on survival over a 15-year period. N Engl J Med 1996;334:216.
84. Richardson PD, Davies MJ, Born GV. Influence of plaque configuration and stress distribution on Assuring of coronary atherosclerotic plaques. Lancet 1989;2:941.
85. Royse AG, Royse CF, Tatoulis J, Grigg LE, Shah P, Hunt D, et al. Postoperative radial artery angiography for coronary artery bypass surgery. Eur J Cardiothorac Surg 2000; 17:294
86. Suma H, Isomura T, Horii T, Sato T. Late angiographic result of using the right gastroepiploic artery as a graft. J Thorac Cardiovasc Surg 2000;120:496
87. Gurne O, Buche M, Chenu P, Paquay JL, Pelgrim JP, Louagie Y, et al. Quantitative angiographic follow-up study of the free inferior epigastric coronary bypass graft. Circulation 1994;90:II148
88. Minick CR, Stemerman MB, Insull W Jr. Role of endothelium and hypercholesterolemia in intimal thickening and lipid accumulation. AmJPathol1979;95:131.
89. Smith SH, Geer JC. Morphology of saphenous vein-coronary artery bypass grafts: seven to 116 months after surgery. Arch Pathol Lab Med 1983;107:13.
90. Campeau L, Enjalbert M, Lesperance J, Bourassa MG, Kwiterovich P Jr, Wacholder S, et al. The relation of risk factors to the development of atherosclerosis in saphenous- vein bypass grafts and the progression of disease in the native circulation. N Engl J Med 1984;311:1329.
91. Campeau L, Enjalbert M, Lesperance J, Vaislic C, Grondin CM, Bourassa MG. Atherosclerosis and late closure of aortocoronary saphenous vein grafts: Sequential angiographic studies at 2 weeks, 1 year, 5 to 7 years, and 10 to 12 years after surgery. Circulation 1983;68:II1.
92. Solymoss BC, Nadeau P, Millette D, Campeau L. Late thrombosis of saphenous vein coronary bypass grafts related to risk factors. Circulation 1988;78:I140
93. Guthaner DF, Robert EW, Alderman EL, Wexler L. Long-term serial angiographic studies after coronary artery bypass surgery. Circulation 1979;60:250.
94. Reichle FA, Stewart GJ, Essa N. A transmission and scanning electron microscopic study of luminal surfaces in Dacron and autogenous vein bypasses in man and dog. Surgery 1973;74:945.
95. Chang BB, Paty PS, Shah DM, Leather RP. The lesser saphenous vein: an underappreciated source of autogenous vein. J Vasc Surg 1992;15:152
96. Sahn DJ, Barratt-Boyes BG, Graham K, Kerr A, Roche A, Hill D, et al. Ultrasonic imaging of coronary arteries in open-chest humans: evaluation of coronary atherosclerotic lesions during cardiac surgery. Circulation 1982;66:1034.
97. Laub GW, Muralidharan S, Clancy R, Eldredge WJ, Chen C, Adkins MS, et al. Cryopreserved allograft veins as alternative coronary artery bypass conduits: early phase results. Ann Thorac Surg 1992;54:826
98. Bourassa MG, Lesperance JJ, Corbara F, Saltiel J, Campeau L. Progression of coronary disease 5 to 7 years after aortocoronary bypass surgery. Cleve Clin Q 1978;45:175.
99. Guthaner DF, Robert EW, Alderman EL, Wexler L. Long-term serial angiographic studies after coronary artery bypass surgery. Circulation 1979;60:250.
100. Goy JJ, Eeckhout E, Burnand B, Vogt P, Stauffer JC, Hurni M, et al. Coronary angioplasty versus left internal mammary artery grafting for isolated proximal left anterior descending artery stenosis. Lancet 1994;343:1449
101. Sergeant P, Blackstone E, Meyns B, Stockman B, Jashari R. First cardiological or cardiosurgical reintervention for ischemic heart disease after primary coronary artery bypass grafting. Eur J Cardiothorac Surg 1998; 14:480.
102. Janardhan T, Ross JK, Shore DF, Lamb RK, Monro JL. Reoperation for recurrent angina after aortocoronary bypass surgery. Eur J Cardiothorac Surg 1990;4:29.
103. Endo M, Nishida H, Tomizawa Y, Kasanuki H. Benefit of bilateral over single internal mammary artery grafts for multiple coronary artery bypass grafting. Circulation 2001;104:2164
104. Qazi A, Garcia JM, Mispireta LA, Corso PJ. Reoperation for coronary artery disease. Ann Thorac Surg 1981;32:16.
105. Loop FD, Lytle BW, Cosgrove DM, Woods EL, Stewart RW, Golding LA, et al. Reoperation for coronary atherosclerosis. Changing practice in 2509 consecutive patients. Ann Surg 1990;212:378.
106. Sharon Ann Hunt, Alice K. Jacobs and Joseph P. Ornato Raymond J. Gibbons, Gabriel Gregoratos, Jonathan L. Halperin, Loren F. Hiratzka,Smith, Jr, Joseph S. Alpert,Jeffrey L. Anderson, David P. Faxon, Valentin Fuster,Marlow, William C. Nugent, Thomas A. Orszulak, Elliott M. Antman, Sidney C.Herrmann, L. David Hillis, Adolph M. Hutter, Jr, Bruce Whitney Lytle, Robert A.H. Edwards, Gordon A. Ewy, Timothy J. Gardner, James C. Hart, Howard C. Kim A. Eagle, Robert A. Guyton, Ravin Davidoff, Fred ACC/AHA 2004 Guideline Update for Coronary Artery Bypass Graft Surgery: Summary Article : A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1999 Guidelines for Coronary Artery Bypass Graft Surgery) Circulation 2004, 110:1168-1176 doi: 10.1161/ 01.CIR. 00001 38790.14877.7D
107. Savage MP, Douglas JS Jr, Fischman DL, Pepine CJ, King SB 3rd, Werner JA, et al. Stent placement compared with balloon angioplasty for obstructed coronary bypass grafts. Saphenous Vein De Novo Trial Investigators. N Engl J Med 1997;337:740.
108. King SB 3rd, Lembo NJ, Weintraub WS, Kosinski AS, Barnhart HX, Kutner MH, et al. A randomized trial comparing coronary angioplasty with coronary bypass surgery. Emory Angioplasty versus Surgery Trial (EAST). N Engl J Med 1994;331:1044.
109. Yeh TJ, Heidary D, Shelton L. Y-grafts and sequential grafts in coronary bypass surgery: a critical evaluation of patency rates. Ann Thorac Surg 1979;27:409.
110. Schofield PM, Sharpies LD, Caine N, Burns S, Tait S, Wistow T, et al. Transmyocardial laser revascularisation in patients with refractory Angin: a randomised controlled trial. Lancet 1999;353:519.
111. Vale PR, Losordo DW, Milliken CE, Maysky M, Esakof DD, Symes JF, et al. Left ventricular electromechanical mapping to assess efficacy of phVEGF165 gene transfer for therapeutic angiogenesis in chronic myocardial ischemia. Circulation 2000; 102:965.
112. Ehsan A, Mann MJ, Dell'Acqua G, Dzau VJ. Long-term stabilization of vein graft wall architecture and prolonged resistance to experimental atherosclerosis after E2F decoy oligonucleotide gene therapy. J Thorac Cardiovasc Surg 2001;121:714.
113. Alderman EL, Fisher LD, Litwin P, Kaiser GC, Myers WO, Maynard C, Levine F, Schloss M. Results of coronary artery surgery in patients with poor left ventricular function (CASS). Circulation. 1983;68:785–795.
114. Luciani GB, Faggian G, Razzolini R, Livi U, Bortolotti U, Mazzucco A. Severe ischemic left ventricular failure: coronary operation or heart transplantation? Ann Thorac Surg. 1993;55:719 –723.
115. Hata M, Raman JS, Storer M, Matalanis G, Rosalion A, Buxton BF, Hare D. The mid-term outcome of geometric endoventricular repair for the patients with ischemic left ventricular dysfunction. Ann Thorac Cardiovasc Surg. 2003;9:241–244.
116. Passamani E, Davis KB, Gillespie MJ, Killip T. A randomized trial of coronary artery bypass surgery. Survival of patients with a low ejection fraction. N Engl J Med. 1985;312:1665–1671

117. Di Carli MF, Maddahi J, Rokhsar S, Schelbert HR, Bianco-Batlles D, Brunken RC, Fromm B. Long-term survival of patients with coronary artery disease and left ventricular dysfunction: implications for the role of myocardial viability assessment in management decisions. J Thorac Cardiovasc Surg. 1998;116:997–1004. Carr JA, Haithcock BE
118. Paone G, Bernabei AF, Silverman NA. Long-term outcome after coronary artery bypass grafting in patients with severe left ventricular dysfunction. Ann Thorac Surg. 2002 Nov;74(5):1531-6.
119. Osakada G, Hess OM, Gallagher KP, Kemper WS, Ross J Jr. End-systolic dimension-wall thickness relations during myocardial ischemia in conscious dogs. A new approach for defining regional function. Am J Cardiol 1983;51:1750–8.
120. Pasini E, Ferrari G, C remona G, Ferrari M. Revascularization of severe hibernating myocardium in the beating heart: early hemodynamic and metabolic features. Ann Thorac Surg 2001;71:176–9.
121. Hughes GC, Landolfo CK, Yin B, DeGrado TR, Coleman RE, Landolfo KP. Is chronically dysfunctional yet viable myocardium distal to a severe coronary stenosis hypoperfused? Ann Thorac Surg 2001;72:163–8.
122. Mickleborough LL, Carson S, Tamariz M, Ivanov J. Results of revascularization in patients with severe left ventricular dysfunction. J Thorac Cardiovasc Surg 2000;119:550–7.