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Original Article

Left internal mammary on-lay patch vs. saphenous vein patch in reconstructing diffusely diseased left anterior descending artery

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Abstract

Background: Several operative techniques were described to reconstruct the diffusely diseased left anterior descending coronary artery (LAD). The superiority of the left internal mammary artery (LIMA) vs. the saphenous vein patch is controversial in LAD reconstruction. Thus, this study compared LIMA on-lay patch vs. saphenous vein patch in reconstructing diffusely diseased LAD artery.

Methods: This study was conducted between June 2020 and May 2022 including 60 patients with a diffusely diseased LAD. LIMA patch was used in 30 patients (Group I) and saphenous vein patch in 30 patients (Group II) without endarterectomy. Males presented 85%; the mean age was 56.68 ± 6.44 years. The mean patch length in the LIMA group was 4.48±0.87 cm and 4.60± 0.93 cm in the saphenous vein group.

Results: The mean aortic cross-clamp and cardiopulmonary bypass times were 66.80± 19.93 and 108.00± 25.74 minutes in the LIMA group and 84.40± 30.65 and 132.53± 45.41 minutes in the venous Group (P= 0.011 and 0.013, respectively). The mean intensive care unit stay was 50.40 ± 38.65 hours in Group I and 92.00± 51.62 hours in Group II (P< 0.001). Four patients (13.3%) needed an intra-aortic balloon pump (IABP) in Group I, and 11 patients (36.7%) in Group II (P= 0.037). Postoperative low cardiac output occurred in 13.3% of Group I and 53.3% in Group II (P= 0.001). Postoperative atrial fibrillation occurred in 13.3% of Group I, while in Group II was 33.3% (P= 0.067). The renal complications were 3.3% in Group I and 16.7% in Group II (P= 0.085). Two patients (6.7%) were complicated with bleeding in Group I, and nine (30.0%) in Group II (P= 0.02). The postoperative ejection fraction was 58.17± 5.25% in Group I and 53.3± 5.23% in Group II (P= 0.001). On the first postoperative day, the creatine kinase-myoglobin binding level was 61.73± 30.19 IU/L in Group I and 92.63± 45.88 IU/L in Group II (P= 0.004). Hospital mortality occurred in one patient (3.3%) in Group I and two in Group II (6.7%) (P> 0.99).

Conclusion: LAD reconstruction using the LIMA patch could have better early outcomes than the saphenous vein patch.

KEYWORDS

Coronary Artery Bypasses Grafting; Left Anterior Descending Artery; Left Internal Mammary Artery; Saphenous Vein Graft; Venous patch

Article History

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Introduction

Total myocardial revascularization is the primary goal of coronary artery bypass grafting (CABG) [1-3]. Percutaneous coronary interventions have increased recently, and the

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number of high-risk and elderly patients presenting for surgery has increased [4].

Conventional CABG does not achieve adequate myocardial revascularization in diffusely diseased left anterior descending coronary artery (LAD) [5]. Endarterectomy for severely atherosclerotic coronary artery disease (CAD) has a higher surgical risk and poor late outcomes [6,7]. Reconstruction of diffusely diseased LAD either with left internal mammary artery (LIMA) on-lay patch or saphenous vein patch without endarterectomy by opening the whole wall of the diseased segment(s) has less risk and complications than endarterectomy technique [8,9].

Coronary endarterectomy was first described by Bailey and coworkers [10]. The LAD reconstruction with saphenous vein or LIMA combined with endarterectomy was introduced by Fundaro [11] and others [12-16] to achieve better long-term patency of LIMA graft [17, 18] and avoid the drawbacks of coronary endarterectomy.

The superiority of LIMA vs. saphenous vein patch is controversial. The objective of this study was to compare LIMA on-lay patch vs. saphenous vein patch in reconstructing diffusely diseased LAD artery.

Patients and Methods

Design and patients

This is a prospective study for patients with diffusely diseased LAD who were not candidates for other conventional grafting techniques, such as double or sequential grafting. Patients were admitted for CABG from June 2020 until May 2022. The study was carried out after obtaining the approval of the local Ethical Committee, and written consent was obtained before enrollment.

Sixty patients were chosen for reconstruction of a diffusely diseased LAD. The patients were categorized into Group I (n= 30), in which the LAD was reconstructed with a direct LIMA patch, and Group II (n= 30), in which the LAD was reconstructed using a saphenous vein patch, then LIMA was anastomosed to the patch. Patients were assigned into groups according to LAD arteriotomy length, LAD lesion site, and LIMA length. We used a direct LIMA patch in the cases of more proximal LAD lesions with adequate length of LIMA. In contrast, we used a venous patch in cases of long LAD arteriotomy up to a distal quarter to avoid using the terminal part of LIMA, which may be spastic or small in caliber, and in cases of LIMA with a short length, to avoid traction on anastomosis of short LIMA to LAD. The study focused on the short-term clinical outcome and its safety by monitoring intraoperative and postoperative complications. Early clinical outcome was defined as results postoperative during the hospital stay.

We included patients with long-segment diffusely diseased LAD, with good ejection fraction and elective surgery. Patients with associated valve surgery, left ventricular ejection fraction less than 40%, and severe comorbidities (renal or liver failure) were excluded.

Preoperative preparation:

A complete history of patients was taken, including the presence of chronic diseases such as diabetes, hypertension, and recent myocardial infarction in the last two months. Laboratory investigations included complete blood count, troponin, and liver and kidney functions. electrocardiogram and chest X-ray (postero-anterior) were done. A complete echocardiographic study was done for all patients, including left ventricular end-diastolic diameter, end-systolic diameter, ejection fraction, wall motion abnormality, and valve assessment. A dobutamine stress echocardiography was performed in patients associated with moderate ischemic mitral valve regurgitation to show regurgitation improvement. A thallium viability study was done in patients of akinetic apex, bad quality LAD, or totally occluded LAD to show viability in LAD territory.

Operative Technique:

All 60 patients were done with the on-pump CABG technique. Cardiopulmonary bypass was initiated after the preparation of either saphenous vein grafts or internal mammary artery grafts. Distal anastomoses of coronary targets other than LAD were done first by 7/0 continuous

polypropylene suture; then LAD was explored, searching for a good target zone.

In Group I, the distal coronary artery site that had to be bypassed was identified. The LAD was incised along the diseased segment, and the arteriotomy was extended distally until the non-diseased arterial lumen was reached. However, the LAD was not opened at the first proximal significant lesion level to avoid competitive flow between the native LAD and the LIMA. The length of arteriotomy might involve the middle and distal third of LAD then the LIMA patch was sewn in place with 7/0 or 8/0 continuous polypropylene suture. (Figure 1)

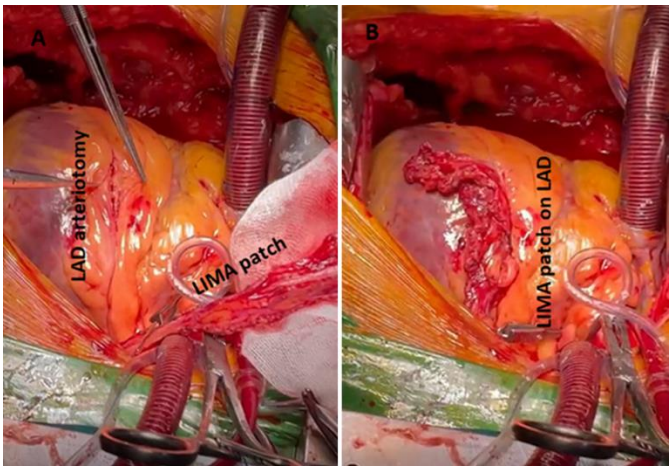

Figure 1: An intraoperative photo of left anterior descending (LAD) coronary artery reconstruction with Left internal mammary artery (LIMA) patch; [A] preparation of the LIMA patch and opening of the LAD, [B] LAD reconstruction with LIMA patch

In Group II: incision of the LAD and extension of the arteriotomy along the diseased segment, then the saphenous vein patch with no valves was opened longitudinally and sewn in place with a 7/0 continuous polypropylene suture. Meticulous attention was devoted to avoiding redundant patches that may promote kinetic energy loss. The LIMA graft was fashioned and anastomosed entirely to the vein patch through a 5-10mm incision by a 7/0 continuous polypropylene suture. Rewarming started near the end of LIMA's anastomosis to LAD before the aortic cross-clamp was removed.

Statistical analysis:

Data were presented as mean and standard deviation, and categorical data as frequencies and percentages. Descriptive analysis was performed using SPSS v23 (IBM Corp- Armonk- NY- USA). Continuous data were compared with the t-test, and categorical data with the Chi-squared test. Friedman test was used to compare the repeated measures in the same group. Statistical significance was assumed if a p-value of 0.05 or less was achieved.

Results

Preoperative data

The included 60 patients in the study were divided into two groups, LIMA patch group (I) included 30 patients with a mean age of 55.90± 5.95 years, and 25 of them were males (83.3%). The venous patch group (II) included 30 patients with mean age 57.47± 6.91 years, and 26 of them were males (86.7%). The mean BMI of Group I was 31.37 ± 4.77 kg/m2, while in Group II was 30.43± 4.09 kg/m2.

Table 1: Comparison between the LIMA group (Group I) and venous Group (Group II) regarding preoperative data. Continuous data were presented as mean and standard deviation and categorical data as numbers and percentages

	LIMA group (n= 30)	Venous Group (n= 30)	P
Age (years)	55.90 ± 5.95	57.47 ± 6.91	0.350
Male	25 (83.3%)	26 (86.7%)	0.718
BMI (Kg/m2)	31.37 ± 4.77	30.43 ± 4.09	0.418
Diabetes	16 (53.3%)	16 (53.3%)	1.000
Hypertension	19 (63.3%)	21 (70%)	0.584
Smoker	15 (50%)	12 (40%)	0.436
NYHA class			
Class II	17 (56.7%)	18 (60%)	0.793
Class III	13 (43.3%)	12 (40%)	
Previous MI	12 (40%)	15 (50%)	0.436
PVD	4 (13.3%)	3 (10%)	0.688

LIMA: left internal mammary artery; BMI: body mass index; MI: Myocardial infarction; PVD: Peripheral vascular disease

Table 2: Comparison between the LIMA group (Group I) and venous Group (Group II) regarding preoperative echocardiographic data. Continuous data were presented as mean and standard deviation, and categorical data as numbers and percentages

Echocardiography	LIMA group (n= 30)	Venous Group (n= 30)	P
LVED (cm)	5.70 ± 0.41	5.68 ± 0.21	0.780
LVES (cm)	3.47 ± 0.43	3.69 ± 0.49	0.065
EF%	54.40 ± 6.00	52.93 ± 5.19	0.315
Mitral valve regurgitation			
No	16 (53.3%)	17 (56.7%)	
Mild	6 (20.0%)	6 (20.0%)	0.953
Moderate	8 (26.7%)	7 (23.3%)	
RWMA in LAD territory			
No	6 (20.0%)	10 (33.3%)	
Hypokinsia	18 (60.0%)	15 (50.0%)	0.506
Akinesia	6 (20.0%)	5 (16.7%)	
dobutamine stress echocardiography	8 (26.7%)	7 (23.3%)	0.766
Thallium viability study	7 (23.3%)	4 (13.3%)	0.317

LIMA; left internal mammary artery; LVED: left ventricle end diastole diameter; LVES: left ventricle end systole diameter; EF: ejection fraction; RWMA: Regional wall motion abnormalities; LAD: left anterior descending artery

Regarding preoperative risk factors, each Group had 16 diabetic patients (53.3%). There were 19 hypertensive patients (63.3%) in Group I, while 21 hypertensive patients were in Group II (70.0%). Group I had 12 patients who had a previous myocardial infarction (MI) for more than at least one month (40%), while 15 patients (50%) were in Group II. (Table 1)

Regarding preoperative echocardiography, the mean ejection fraction (EF) in Group I was 54.40± 6.00 and 52.93± 5.19 in Group II. The mean left ventricle end-diastolic diameter (LVED) in Group I was 5.70± 0.41 cm, while in Group II was 5.68 ± 0.21 cm. Group I had eight patients with moderate mitral regurgitation (MR) (26.7%), while seven patients with moderate MR (23.3%) were in Group II. (Table 2)

Operative data

The mean length of the patch in the LIMA group was 4.48± 0.87 cm and 4.60± 0.93 cm in the venous group. The mean aortic cross-clamp and bypass times were 66.80± 19.93 and 108.00± 25.74 minutes in the LIMA group and 84.40 ± 30.65 and 132.53± 45.41 minutes in the venous group.

Table 3: Comparison between the LIMA group (Group I) and venous Group (Group II) regarding the intraoperative data. Continuous data were presented as mean and standard deviation and categorical data as numbers and percentages

	LIMA group (n= 30)	Venous Group (n= 30)	P
Length of the patch (cm)	4.48 ± 0.87	4.60 ± 0.93	0.617
Number of grafts	3.43 ± 1.01	3.30 ± 1.12	0.629
Ischemic time (min)	66.80 ± 19.93	84.40 ± 30.65	0.011
Total bypass time (min)	108.00 ± 25.74	132.53 ± 45.41	0.013
Coming off bypass			
No support	14 (46.7%)	4 (13.3%)	
Minimal inotrope	8 (26.7%)	7 (23.3%)	0.017
High inotrope	6 (20.0%)	15 (50.0%)	
IABP	2 (6.7%)	4 (13.3%)	
IABP	4 (13.3%)	11 (36.7)	0.037
Levosemindan	2 (6.7%)	8 (26.7%)	0.038
High Inotropes	6 (20.0%)	20 (66.7%)	<0.001

LIMA: left internal mammary artery; IABP: intra-aortic balloon pump

Table 4: Comparison between the LIMA group (Group I) and venous Group (Group II) regarding postoperative data. Continuous data were presented as mean and standard deviation, and categorical data as numbers and percentages

	LIMA group (n= 30)	Venous Group (n= 30)	P
ECG ST changes	5 (16.7%)	12 (40%)	0.045
Low COP	4 (13.3%)	16 (53.3%)	0.001
AF	4 (13.3%)	10 (33.3%)	0.067
Ventricular arrhythmia	2 (6.7%)	8 (26.7%)	0.038
Renal complications	1 (3.3%)	5 (16.7%)	0.085
Reopening	2 (6.7%)	8 (26.7%)	0.038
Bleeding	2 (6.7%)	9 (30%)	0.020
Neurological complications	1 (3.3%)	3 (10%)	0.301
Pulmonary complications	3 (10%)	5 (16.7%)	0.448
Wound infection	2 (6.7%)	5 (16.7%)	0.228
Ventilation hours	15.07 ± 7.94	23.60 ± 12.62	0.004
ICU stay (hours)	50.40 ± 38.65	92.00 ± 51.62	0.000
Total hospital stay (day)	7.37 ± 1.71	10.40 ± 1.63	0.000
CK-MB 1st day	61.73 ± 30.19	92.63 ± 45.88	0.004
CK-MB 2nd day	51.63 ± 26.25	72.60 ± 32.08	0.019
CK-MB 3rd day	32.70 ± 20.13	44.80 ± 25.39	0.034
Friedman test P-value for within-group change in CK-MB	<0.001	<0.001	

LIMA; left internal mammary artery; ICU: intensive care unit; CK-MB: creatine kinase-myoglobin binding; ECG: electrocardiogram; AF: atrial fibrillation; COP: cardiac output

Four patients (13.3%) needed an intra-aortic balloon pump (IABP) in Group I, with 2 of them (6.7%) during coming off bypass, and 11 patients (36.7%) in Group II with 4 of them (13.3%) during coming off bypass. (Table 3)

Postoperative data

The mean ventilation time was 15.07± 7.94 hours in Group I, while in Group II was 23.60± 12.62 hours. The mean time of intensive care unit stay was 50.40± 38.65 hours in Group I and 92.00± 51.62 hours in Group II. Regarding total hospital stay days, in Group I, the mean number of days was 7.37± 1.71 days, while in Group II was 10.40± 1.63 days. (Table 4)

The mean creatine kinase (CK) levels on the first day postoperatively in Group I was 854.87± 210.90 IU/L, while in Group II was 1128.17± 567.06 IU/L. Regarding postoperative troponin, on the first day, two patients in Group I were positive (6.7%), while seven patients (23.3%) were positive in Group II. On the first day postoperative, the mean creatine kinase-myoglobin binding (CK-MB) levels were 61.73± 30.19 IU/L in Group I and 92.63± 45.88 IU/L in Group II. (Table 4)

Postoperative low cardiac output in Group I was 13.3%, while in Group II was 53.3%. Postoperative atrial fibrillation was 13.3% in Group I, while in Group II was 33.3%. The renal complications were 3.3% in Group I, while 16.7% in Group II. There were two patients (6.7%) with bleeding in Group I and nine (30.0%) in Group II. (Table 4)

The mean postoperative ejection fraction (EF) was 58.17± 5.25 % in Group I and 53.33 ± 5.23 in Group II. A statistically significant difference was found between the two groups regarding echocardiography postoperative data. (Table 5)

It is noted that there was no statistically significant difference between pre and postoperative echocardiographic data in the venous group.

Follow-up data

During 30 days follow-up, one patient (3.3%) came with sternal wound infection in Group I, while two patients (6.7%) were in Group II. Two patients (6.7%) in Group II came with moderate pleural effusion, and one patient (3.3%) in Group II came with manifestations of heart failure.

Discussion

Complete revascularization in CABG is crucial to improve early and late outcomes after surgery. Conventional procedures cannot achieve satisfactory results in severely diseased left anterior descending coronary artery [19]. However, Tasdemir and colleagues [15] have shown that extended LAD revascularization was associated with four folds hospital mortality and 5- 6 folds in-hospital myocardial infarction, compared to conventional CABG.

In this study, we chose a LIMA patch and saphenous vein patch as methods for the reconstruction of diffusely diseased LAD to assess the effect of each technique on the early outcome of patients and which method is better than the other. Ogus and colleagues [20] used LIMA on-lay patches for the reconstruction of LAD based on the superior patency rate of the LIMA over the vein patch, as the vein patch technique is more time-consuming. The larger diameter of the saphenous vein may adversely influence the flow patterns. This explains the significant differences in CK, CK-MB, and troponin T levels between the two groups higher in the venous group postoperative. While Santini and associates [21] used a saphenous vein patch for LAD reconstruction, and then The LIMA was anastomosed to this pliable vein patch instead of the calcified LAD wall.

According to Lüscher and colleagues [22], the advantage of LIMA on-lay patch is to provide better vasomotor function and adjust the flow rate in proportion to the distal runoff.

We did not prefer an endarterectomy due to the reported surgical risk of a combined endarterectomy with patch angioplasty. Fukui and associates [23] demonstrated a statistically significant higher rate of perioperative MI in this subgroup of patients compared to those benefiting from angioplasty alone. Besides, we did not prefer to do off-pump CABG for more safety, and accurate anastomosis as a long segment anastomosis of LAD needs an arrested heart on CPB. However, off-pump CABG was reported successfully in other series [15,23,24].

In our study, there were statistically significant differences as to operative data (CPB time and ischemic time), CPB weaning data (need for inotropes or IABP), postoperative data (ICU and hospital stay times), postoperative complications and postoperative echocardiography data with a preference of LIMA on-lay patch over SVG patch. On the other side, other series reported no differences in operative or postoperative data [20,25].

Table 5: Comparison between the LIMA group (Group I) and venous Group (Group II) regarding postoperative echocardiography

	LIMA group (n= 30)	Venous Group (n= 30)	P
Echocardiography postoperative			
EF%	58.17 ± 5.25	53.33 ± 5.23	0.001
Echocardiography postoperative			
Mitral Valve regurgitation			
No	23 (76.7%)	11 (36.7%)	0.019
Mild	4 (13.3%)	13 (43.3%)	
Moderate	2 (6.7%)	4 (13.3%)	
Severe	1 (3.3%)	2 (6.7%)	
Echocardiography postoperative			
RWMA in LAD			
No	24 (80.0%)	13 (43.3%)	0.014
Hypokinesia	4 (13.3%)	12 (40.0%)	
Akinesia	2 (6.7%)	5 (16.7%)	

LIMA: left internal mammary artery; EF: ejection fraction; RWMA: regional wall motion abnormalities; LAD: left anterior descending artery

It is noted that the patients who used IABP early during the coming-off bypass had a smooth course in ICU without mortality. This explains the advantage of early IABP post CABG to enhance coronary perfusion and decrease afterload to enhance contractility. The higher incidence of postoperative bleeding in the venous group may be due to the long bypass time, which affects coagulation; the higher incidence of patients needing IABP, which causes thrombocytopenia and heparin, was inserted in all patients with the venous group a few hours after surgery. At the same time, other series reported none of the patients re¬quired re-exploration for bleeding [26,27].

The higher incidence of atrial fibrillation (AF) was in elder patients above 60 years old, obese patients and patients with ejection fraction less than 45%, LVED more than 6 cm, and patients who had moderate mitral valve regurgitation. All patients with ventricular arrhythmia responded after electrolytes adjustment, amiodarone infusion, and DC shock, except one in Group II, who responded only after IABP insertion. Neurological complications included patients who were above 60 years old with significant lesions of more than 50% in one of two internal carotid arteries. It was in the form of a stroke in one patient in Group I, while three patients in Group II in the form of stroke in one patient and delayed recovery in the other two patients. According to renal complications, six patients had creatinine levels of more than 2 mg/dl; only one needed renal dialysis in Group II, and this patient died. It is noted that postoperative chest infections occurred in patients with prolonged ventilation for more than 48 hours.

According to postoperative ECG changes, two patients of Group I needed IABP with one mortality case, and three patients needed high inotropes. While in Group II, five patients with ECG changes needed IABP with two mortality cases. There was a statistically significant difference found between the two studied groups regarding postoperative echocardiography postoperative of EF, MV regurgitation, and RWMA in LAD territory with better results in the LIMA group, while other series showed no significant differences [28,29].

Regarding postoperative hospital mortality, one patient died (3.3%) in Group I, while two died in Group II (6.7%).

Study limitations

We have some limitations in our study. Among these is the given relatively small sample size, the length of the clinical follow-up was only immediate postoperative assessment, and longer durations of follow-up are needed to confirm these results and lack of postoperative follow-up angiography or multislice computed coronary angiography.

Conclusion

LAD reconstruction with a LIMA patch could have a better short-term outcome than a saphenous vein patch without an endarterectomy for a diffusely diseased left anterior descending coronary artery.

Conflict of interest: Authors declare no conflict of interest.

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