Left Anterior Descending Coronary Artery Reconstruction: Left Internal Mammary Artery Patch versus Great Saphenous Vein Patch

Shady Hosny Eltabie*, Eman Fadel, Mohammed Sanad, Ahmed K. Abdalla

Department of Cardiothoracic Surgery, Faculty of Medicine, Mansoura University, Egypt

Abstract

Background: Cardiovascular diseases (CVDs) account for about one third of all global mortalities and are a major contributor to disability. The aim of this study was to evaluate the early clinical and angiographic outcomes of left anterior descending (LAD) reconstruction using the left internal mammary artery (LIMA) patch versus the GSV. Methods: This clinical comparative study included 80 patients diagnosed with ischemic heart disease (IHD) who were divided into two groups, group A (LIMA group) included 40 patients underwent LAD reconstruction using a LIMA patch and group B (GSV group) included 40 patients underwent LAD reconstruction using a great saphenous vein (GSV) patch. Follow-up was every 2 weeks, 1 month, 3 months, and 6 months postoperative then annually via outpatient visits. Echocardiography, multi-slice computed tomography coronary angiography or coronary angiographies were performed at 6–12 months to assess anastomosis patency. Results: There was a statistically significant difference regarding NYHA classification, indicating a better functional status in the LIMA group. There was a statistically significant difference in LVED, indicating that reduction was greater in the LIMA group. This suggested better left ventricular remodeling in LIMA group postoperatively. There was a statistically significant difference in ejection fraction, indicating that improvement was significantly higher in the LIMA group compared to the GSV group. This suggested better myocardial recovery and contractile function in the LIMA group postoperatively. Conclusion: LIMA adoption for reconstruction of diffusely diseased LAD is associated with favorable operation, early and short-term outcome as regard lower MACES, lower rehospitalization and superior patency rate.

Keywords: Left Internal Mammary Artery, Ischemic Heart Disease, Great Saphenous Vein

1. Introduction

Globally, CVDs account for about one third of all mortalities and a major contributor to disability [1]. Ischemic heart disease is considered the leading cause of deaths worldwide with a high economic burden and a threat against the sustainable development [2, 3]. With specific look to our region of the Middle East and North Africa; in 2019, IHD accounted for about 2.55 million cases (95% UI 2.29-2.83) with an increasing trend of the disease with the growing population [4, 5].

The principal etiology of IHD is a coronary atherosclerotic process, which results in luminal stenosis, thrombosis and embolization with the resultant clinical manifestations of IHD [6]. The introduction of percutaneous coronary intervention (PCI) and the innovations in stent technology have led to tremendous changes in the treatment of coronary artery disease (CAD), however, coronary artery bypass grafting (CABG) has been considered the mainstay treatment of IHD for decades due to its efficacy and better outcomes especially in patients with multi-vessel and complex CAD [7, 8].

Over the recent years, the incidence of complex CAD has increased. However, conventional CABG surgery may not be able to fully revascularize some patients, especially those with complex CAD. Reconstruction of diffusely diseased coronary arteries is most often performed on the left anterior descending (LAD) artery, since it is the most critical vessel for myocardial perfusion [9]. The procedure may involve extended arteriotomy with onlay patch angioplasty using the left internal mammary artery (LIMA) or great saphenous vein (GSV), with or without concomitant endarterectomy [10]. This approach allows revascularization of long atherosclerotic segments that are otherwise unsuitable for conventional bypass. Although technically challenging and associated with low operative mortality, high graft patency, and favorable long-term survival, making it a valuable strategy for complete myocardial revascularization in patients with diffuse coronary artery disease [11, 12]. So, aim of this study was to evaluate the early clinical and angiographic outcomes of LAD reconstruction using LIMA patch versus the GSV.

2. Patients and methods

This study was a clinical ambispective (retrospective-prospective) comparative study conducted at the Cardiothoracic and Vascular Surgery Center (CVSC), Mansoura University. The retrospective phase covered the period from March 2022 to February 2023 and included 34 cases representing 42.5 % of the study cases, while the prospective phase started in March 2023 till 2025 and include 46 cases representing 57.5% of the study cases, with a minimum follow-up period of six months after the last enrolled patient. To ensure harmonization between retrospective and prospective data, the same inclusion and exclusion criteria, surgical techniques, and follow-up protocols were applied to both patient groups. Data from the retrospective phase were extracted from electronic medical records and verified against surgical notes and imaging reports. Prospective data were collected using standardized case report forms (CRF).

A total of 80 patients diagnosed with IHD and diffusely diseased LAD artery requiring CABG with LAD reconstruction were enrolled. Patients were divided into two groups, group A (LIMA group) included 40 patients underwent LAD reconstruction using a LIMA patch and group B (GSV group) included 40 patients underwent LAD reconstruction using a GSV patch. LIMA was used for LAD reconstruction when its length was sufficient to cover the diffusely diseased segment and when its diameter matched the LAD coronary artery.

This study included patients aged 40–75 years undergoing on-pump CABG with indications for LAD reconstruction, with or without endarterectomy, with chronic total occlusion (CTO) of the LAD, defined as complete occlusion of ≥ 3 months duration with TIMI 0 flow with coronary luminal diameters below 1 mm, with heavily calcified plaques impeding bypass graft suturing, with multiple obstructions in the LAD. With diffusely diseased LAD with atherosclerosis extending into major side branches, and with soft atherosclerotic plaques at risk of disruption and distal embolization. We excluded patients requiring endarterectomy in diffusely diseased vessels other than the LAD and patients needing combined valvular intervention.

2.1. Methods

A thorough preoperative evaluation was conducted for all patients to assess baseline health status, comorbid conditions, and surgical risk. The evaluation included detailed history-taking, physical examination, laboratory investigations, and multimodal imaging to optimize perioperative management. Each patient underwent a comprehensive clinical assessment, which included demographic data (age, gender, smoking status, and past medical history), cardiovascular risk factors assessment (Hypertension (HTN), Diabetes Mellitus (DM), Dyslipidemia, Smoking History and obesity), cardiac symptoms & functional status (New York Heart Association (NYHA) Classification, Canadian Cardiovascular Society (CCS) Angina Classification and history of Myocardial Infarction (MI)) and previous cardiac interventions.

Laboratory Investigations included Complete Blood Count (CBC), coagulation Profile (Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), and INR), serum Electrolytes (Na+, K+, Ca2+), Creatinine, liver Function Tests (AST, ALT, bilirubin levels), fasting Lipid Profile (Total Cholesterol, LDL, HDL, Triglycerides), fasting Blood Glucose and HbA1c for diabetes assessment, and troponin-I in high-risk patients.

a multimodal imaging approach was used to assess coronary artery disease severity, left ventricular function, and surgical feasibility and included 12-lead electrocardiography (ECG), coronary angiography (gold standard), multi-slice computed tomography (MSCT) coronary angiography, transthoracic echocardiography (TTE) and chest CT (When required).

Intraoperative Monitoring included hemodynamic Monitoring (arterial blood pressure, central venous pressure (CVP), pulmonary artery pressures), transesophageal Echocardiography (TEE), and Intra-aortic Balloon Pump (IABP) Support.

2.1.1. Surgical Technique

All patients underwent standard on-pump CABG with LAD reconstruction using either LIMA or GSV patches. The procedure was performed under general anesthesia with endotracheal intubation and invasive hemodynamic monitoring. Standard Median Sternotomy was performed.

The left internal mammary artery (LIMA) was harvested through a median sternotomy, typically after pericardial exposure. The artery run 1–2 cm lateral to the sternum, beneath the endothoracic fascia. Two main harvesting techniques are used pedicled and skeletonized, in our study we used the pedicled technique.

The LIMA is harvested with surrounding veins, fascia, and a cuff of muscle to protect the artery. Dissection begins at the distal end near the xiphoid process, proceeding proximally toward the subclavian artery. Electrocautery device was used to divide side branches, which were clipped or coagulated to prevent bleeding.

The great saphenous vein (GSV) was harvested from the lower limb, usually beginning at the ankle, knee, or groin depending on conduit length requirements. After skin incision, the vein was carefully dissected free from surrounding tissue with preservation of its adventitia, and tributaries are ligated or clipped. Care was taken to avoid traction or direct manipulation of the vein wall to maintain endothelial integrity and reduce the risk of spasm or thrombosis.

Cardiopulmonary bypass (CPB) and myocardial protection included full heparinization was performed to achieve an activated clotting time (ACT) >400 seconds, aortic cannulation and venous cannulation were established. In LAD reconstruction for diffuse coronary disease, the operation began with identification of the left anterior descending (LAD) artery along the anterior interventricular groove. Once the target segment was exposed. After systemic heparinization and establishment of cardioplegic arrest, an arteriotomy was performed using a fine scalpel or micro-scissors, care was taken to avoid injury to adjacent septal perforators and diagonal branches, which must remain patent to preserve myocardial perfusion. The arteriotomy edges were carefully assessed, and any residual intimal flaps or friable plaque are debrided or stabilized to prevent thrombosis.

Regarding patch reconstruction techniques, for group A (LIMA Patch), we prepared the LIMA by trimming branches, longitudinally opened its distal segment to create an onlay patch of sufficient length and width then end-to-side anastomosis was then performed, most commonly using continuous 7-0 or 8-0 polypropylene sutures on a fine needle. Care was taken to avoid narrowing at the heel or toe, bleeding from suture holes, and torsion or tension on the graft.

For group B (GSV Patch), we harvested a segment of great saphenous vein (GSV), ensuring it was free from varicosities and of suitable caliber, The vein was opened longitudinally to create a flat patch, GSV patch was sutured to the arteriotomized LAD with 0/7 or 0/8 Prolene starting at the distal end and running along the back wall, then the front wall.

Then anastomosis was done between the LIMA and reconstructed patch end-to-side fashion. Continuous (running) sutures were the most used technique, faster to perform, less foreign material (knot bulk) inside the vessel, better hemostasis along the entire patch length, with risk to purse string the anastomosis.

Postoperative management included intensive care unit (ICU) admission, with monitoring of postoperative parameters and complications. Patients without endarterectomy took aspirin 100 mg for life, clopidogrel 75 mg for 12 months and warfarin in high-risk patients (AF, EF <40%, cerebrovascular disease), while patients with endarterectomy took heparin bridging with Warfarin until INR 2.0–2.5 and warfarin for 3 months (target INR 2.0–2.5).

2.1.2. Follow-up

Clinical follow-up was 2 weeks, 1 month, 3 months, and 6 months postoperative then annually via outpatient visits. Echocardiography, MSCT coronary angiography or coronary angiography was performed at 6–12 months to assess anastomosis patency.

Primary outcomes included assessment of anastomosis patency at six months, LV function (EF%) and clinical symptoms, while secondary outcomes included aortic cross-clamping and CPB times, length of the reconstruction in cm, postoperative MI, need for IABP, inotropic support, ICU and hospital stay duration, postoperative complications (arrhythmias, bleeding, stroke, pneumonia, hemodialysis requirement, wound complication) and mortality.

2.2. Ethical Statement

This study complies with the Declaration of Helsinki and was approved by the Ethical Committee of Mansoura Faculty of Medicine-Institutional Research Board (MFM-IRB). Written informed consent was obtained from all patients before participation.

2.3. Statistical Analysis

Data analysis was performed using SPSS v27 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± SD or median (IQR) and compared using Student's t-test or Mann-Whitney U test. Categorical variables were expressed as percentages and compared using Chi-square or Fisher's exact test. Missing data was handled using multiple imputations. A p-value < 0.05 was considered statistically significant.

3. Results

Table **(1)** shows that there was no statistically significant difference between either studied group regarding gender, age, height, weight, body mass index (BMI), body surface area (BSA), disease history, risk factors, and echocardiographic data preoperatively, and operative data.

Table 1. Demographic characters, Disease history, risk factors, echocardiographic data, operative data of both groups.

	LIMA N.=40	**GSV** N.=40	P-value
Gender Female Male	 9(22.5%) 31(77.5%)	 4(10%) 36(90%)	0.130
Age (Mean ± SD)	56.15 ± 10.14	56.80 ± 6.95	0.739
Height cm (Mean ± SD)	168.58 ± 8.39	166.80± 8.99	0.365
Weight kg (Mean ± SD)	88.75± 11.43	83.98± 83.98	0.044
BMI (Mean ± SD)	29.43 ± 3.55	27.408 ± 3.64	0.014
BSA (Mean ± SD)	2.04± .129	1.97± .113	0.011
Smoking	20(50.0%)	18(45.0%)	0.654
HTN	27(67.5%)	30(75.0%)	0.459
DM	25(62.5%)	22(55.0%)	0.496
Previous MI	14(35.0%)	16(40.0%)	0.644
NYHA classification Class1 Class2 Class3 Class4	 0(0%) 20(50.0%) 14(35.0%) 6(15.0%)	 0(0%) 19(47.5%) 15(37.5%) 6(15.0%)	0.970
Angina classification Class1 Class2 Class3 Class4	 0(0%) 9(22.5%) 21(52.5%) 8(20.0%)	 0(0%) 11(27.5%) 20(50.0%) 11(27.5%)	 0.705

Echocardiographic data			
LVEDD cm (Median (IQR)*)	5.700(.9)	5.700(.4)	1.000
LVESD cm (Median (IQR))	3.700(.9)	3.750(.9)	1.000
EF (%) (Median (IQR))	53.00(14)	52.50(7)	0.650
Mitral regurgitation NO Mild Moderate Severe	 27(67.5%) 6(15.0%) 7(17.5%) 0(0.0%)	 18(45.0%) 16(40.0%) 5(12.5%) 1(2.5%)	 0.053
RWMA in LAD terriority NO Hypokinesia Akinesia	 25(62.5%) 14(35.0%) 1(2.5%)	 16(40.0%) 23(57.5%) 1(2.5%)	 .125
Length of LAD Patch (cm)	6(3)	7(4)	0.047
Aortic cross clamping (ACC) time (minutes)	96(36)	95(48)	0.214
CBP time (minutes)	154(60)	160(70)	0.379
Need for IABP	1(2.5%)	2(5.0%)	0.556
Inotropes	40(100%)	40(100%)	1.000

*LVED, left ventricular end diastole; LVES, left ventricular end systole. *IQR (Interquartile Range)*

Table **(2)** shows that there was no statistically significant difference between both studied group regarding post-operative data including postoperative myocardial infarction (MI), postoperative atrial fibrillation (AF), acute kidney injury (AKI), stroke, pneumonia, deep sternal wound infection (DSWI), bleeding, reopening for bleeding, in hospital mortality, length of ICU stay & length of hospital stay and no statistically significant difference regarding post-operative Anti-coagulation regimen.

Table 2. Post-operative data and post-operative Anti-coagulation regimen compared between both groups.

	LIMA N.=40	**GSV** N.=40	**P-value**
Postoperative MI	6(15.0%)	14(35.0%)	0.039
Postoperative AF	5(12.5%)	14(35.0%)	0.018
AKI	2(5.0%)	4(10.0%)	0.396
Stroke	1(2.5%)	3(7.5%)	0.305
Pneumonia	5(12.5%)	6(15.0%)	0.745
DSWI	4(10.0%)	5(12.5%)	0.723
Bleeding	5(12.5%)	9(22.5%)	0.239
Reopening for bleeding	2(5.0%)	4(10.0%)	0.396
In hospital mortality	0(0%)	0(0%)	
Length of ICU stay (Median (IQR))	3.00 (1)	3.00 (1)	0.610
Length of hospital stay (Median (IQR))	7.00(1)	7.00(4)	0.790
Postoperative Anti-coagulation regimen			
LAD endarterectomy	8(20.0%)	8(20.0%)	1.000

Aspirin +Plavix	32(80.0%)	32(80.0%)	1.000
Aspirin +Warfarin	8(20.0%)	8(20.0%)	1.000

Table **(3)** shows that there was no statistically significant difference between both studied groups regarding post operative echocardiographic data including left ventricular end-diastolic diameter (LVEDD) and left ventricular end-systolic diameter (LVESD), ejection fraction (EF), mitral valve regurgitation and regional wall motion abnormality (RWMA) in LAD territory. Also, there was no statistically significant difference regarding patency rate as assessed by MSCT at 6 months including LAD anastomosis and Distal run off.

Table 3. Post-operative Echocardiographic data and Patency rate as assessed by MSCT at 6 months

	LIMA N.=40	**GSV** N.=40	**P-value**
LVEDD (Median (IQR))	5.0(.7)	5.3(.8)	0.043
LVESD (Median (IQR))	3.40(.8)	3.40(.9)	0.822
EF (%) (Median (IQR))	62.0(15)	58.0(9)	0.264
Mitral valve regurgitation			
NO	29 (72.5%)	21 (52.5%)	0.233
Mild	10 (25.0%)	15 (37.5%)	
Moderate	1 (2.5%)	3 (7.5%)	
Severe	0 (0.0%)	1 (2.5%)	
RWMA in LAD terriority			
NO	30 (75.0%)	19 (47.5%)	0.041
Hypokinesia	8 (20.0%)	17 (42.5%)	
Akinesia	4 (10.0%)	2 (5.0%)	
Patency rate as assessed by MSCT at 6 months			
LAD anastomosis			0.246
patent	32 (80.0%)	29 (72.5%)	
Mild stenosis	7 (17.5%)	5 (12.5%)	
Moderate stenosis	1 (2.5%)	5 (12.5%)	
Severe stenosis	0 (0.0%)	1 (2.5%)	
Distal run off (good)	32(80.0%)	24(60.0%)	0.051

Table **(4)** shows that there was no statistically significant difference between both studied groups regarding clinical assessment of both groups 6 months postoperative including rehospitalization, heart failure (HF), mortality, angina classification and recurrence of Angina in last follow up. There was statistically significant difference regarding NYHA classification, indicating better functional status in the LIMA group. Regarding Postoperative echocardiographic improvement among both groups, there was statistically significant difference in LVED, indicating that reduction was greater in the LIMA group. This suggested better left ventricular remodeling in the LIMA group postoperatively. There was no statistically significant difference between groups in LVES, but greater reduction observed in LIMA group.

There was statistically significant difference in ejection fraction, indicating that improvement was significantly higher in the LIMA group compared to the GSV group. This suggested better myocardial recovery and contractile function in the LIMA group postoperatively.

Table 4. Clinical assessment and Postoperative echocardiographic improvement among both groups 6 months post-op.

	LIMA N.=40	**GSV** N.=40	**P-value**
Rehospitalization	5(12.5%)	5(12.5%)	1.000
HF	4(10.0%)	6(15.0%)	0.499
Mortality	0	0	
NYHA classification Class1 Class2 Class3 Class4	 3 (7.5%) 30 (75.0%) 7(17.5%) 0 (0%)	 18 (45.0%) 14 (35.0%) 8 (20.0%) 0 (0%)	0.000
Angina classification Class1 Class2 Class3 Class4	 4 10.0% 21 52.5% 11 27.5% 1 2.5%	 4 10.0% 24 60.0% 11 27.5% 4 10.0%	0.572
Recurrence of Angina in last follow up	12 30.0%	8 20.0%	0.302
LVED (Median (IQR))	-12.96% (9.26%)	-8.69% (11.16%)	0.044
LVES (Median (IQR))	-13.33% (13.12%)	-9.67% (18.21%)	0.264
EF (%) (Median (IQR))	14.29% (12.10%)	9.43% (14.36%)	0.014

4. Discussion

Coronary artery bypass grafting is still one of the cornerstones of the treatment of severe coronary artery disease, especially in cases with diffuse diseases of the LAD artery. It has historically been preferred for revascularization of the LAD coronary artery with LIMA over other conduits because of superior long-term patency and its positive association with increased survival. Patients who undergo LIMA to LAD grafting have been shown to survive at rates like aged-matched populations free of coronary disease, with respective 5-, 10-, 15-, and 20-year survival rates of 91.9%, 84.7%, 71.3%, and 56.5%. These results highlight the value of LIMA grafts for recovery of myocardial perfusion and better prognostic outcome for the patients [13].

In contrast, the SVG has been extensively used owing to its great availability and ease of harvesting. But SVGs have an increased risk of graft failure over time. Nearly half of all SVGs will not last beyond 5 to 10 years following CABG, resulting in considerable morbidity and repeat procedures amongst patients. Moreover, the gradual loss of graft patency is due to the processes of intimal hyperplasia and atherosclerotic alterations of vein graft [14].

The aim of this study was to compare the clinical and echocardiographic outcomes of LAD artery reconstruction using a LIMA patch versus a GSV patch in patients with diffusely diseased LAD undergoing CABG. The study sought to determine which technique offers better postoperative myocardial recovery, graft patency, and functional status at six-month follow-up.

The baseline demographics at entry for age, gender, and height were similar in the two groups (e.g., LIMA vs. GSV) and were not statistically different (all P >.05) in our study. Nonetheless, LIMA group had greater BMI (29.43 vs. 27.41), encouraging the speculation that those patients with larger body size were more likely to receive LIMA patch reconstruction.

On the other hand, the results contradicts those of **Fukui *et al.*** [9] who also analyzed a series of 250 patients undergoing long-segment LAD reconstruction using LIMA, with or without endarterectomy. They found no major differences in demographics (e.g., BMI, body weight, etc.) between those who had either LIMA or alternative techniques It is possible that this difference reflects differences and demographic variation within the population. In Fukui's Japanese cohort, conduit selection was mainly determined by anatomy, not by body habitus, and off-pump techniques were employed more frequently.

In our study, the distribution of cardiovascular risk factors, such as smoking, hypertension (HTN), diabetes mellitus (DM), and previous myocardial infarction (MI), was comparable between the LIMA and GSV groups, with no statistically significant differences. This suggests that both groups were well-matched in terms of baseline comorbidities, allowing for a fair comparison of surgical outcomes.

Similarly, **Elsayed *et al.*** [15] conducted a prospective study on 30 patients with diffusely diseased LAD, comparing LIMA onlay patch to saphenous vein patch reconstruction. The study reported no significant differences in demographic or clinical risk factors between the groups, reinforcing the notion that patient selection was balanced and that differences in outcomes could be attributed to the surgical technique rather than underlying comorbidities.

The preoperative echocardiographic characteristics were comparable between the LIMA and GSV groups in our study. Left ventricular end-diastolic diameter (LVEDD) was equal (5.70 cm each group); left ventricular end-systolic diameter (LVESD) was similar (3.70 cm for LIMA versus 3.75 cm for GSV), with no differences found. The LIMA group had a higher EF (53.0% vs 52.5%) which again did not reach statistical significance (p = 0.650). The LIMA group had a better outcome on mitral regurgitation (MR) (67.5% had no MR in the LIMA group vs. 45.0% in the GSV group, p = 0.053). Also slightly less common amongst the LIMA group was the presence of no RWMA in the LAD territory (62.5% vs. 40.0% in GSV) (p = 0.125) like the study of **Ibrahim *et al.*** [16].

In the present study, patients reconstructed with a LIMA patch to the LAD developed postoperative myocardial infarction (MI) less frequently than those reconstructed with a GSV patch (15.0% vs. 35.0%, respectively; p = 0.039). Similarly, postoperative atrial fibrillation (AF) was less frequent in the LIMA group versus the GSV group [12.5% vs 35.0%, respectively (p = 0.018)]. AKI, stroke, pneumonia, DSWI, and bleeding were also slightly increased in the GSV cohort compared to the saphenous cohort, but these differences did not reach statistical significance. Notably, in-hospital mortality was 0% in both groups, and ICU and hospital length of stay was similar.

Also, **Rezk *et al.*** [17] showed that postoperative complication rates were significantly lower in the LIMA-group. Need for IABP was 13.3% in the LIMA group versus 36.7% in the GSV group (p = 0.037); postoperative low cardiac output was identified in 13.3% vs. 53.3%, respectively (p = 0.001). While they did not report MI rates per se, the lower enzyme markers (CK-MB) and improved ejection fraction in the LIMA group. This indicated better myocardial performance in LIMA which reflected better myocardial revascularization with LIMA use.

Furthermore, **Fukui *et al.*** [18] involved 213 patients undergoing extensive LAD reconstruction with LIMA (with or without endarterectomy) also supports our findings in terms of postoperative MI rates. They reported a perioperative MI rate of 5.2% and low cardiac output syndrome in 3.3% of cases. While not directly comparing LIMA to GSV, their data suggest that using the LIMA for reconstruction provides safe and effective myocardial revascularization with low early complication rates.

While our study demonstrated a significant advantage of LIMA patch reconstruction over GSV patching in reducing postoperative MI and AF, several studies in the literature report contrasting findings, indicating comparable outcomes between the two techniques.

For instance, **Myers *et al.*** [19] conducted a retrospective analysis of 224 patients undergoing extensive LAD reconstruction with either saphenous vein patch (n = 101) or LIMA patch (n = 123). They found no significant difference in perioperative MI rates between the two groups, with 4.0% in the vein patch group and 4.1% in the LITA patch group. Operative mortality was also similar, at 3.0% and 4.1%, respectively. These findings suggest that, in their cohort, the choice of conduit did not significantly impact early postoperative outcomes.

Similarly, a study by **Li *et al.* [20]** analyzed 979 patients who underwent LIMA to LAD anastomosis, with or without saphenous vein graft. After propensity score matching, the study found no significant differences in 30-day mortality, postoperative MI, stroke, or atrial fibrillation between the two groups. This suggests that the addition of a saphenous vein patch does not adversely affect short-term outcomes when combined with LIMA grafting.

After operation, the same protocols applied to both groups, postoperative antiplatelet and anticoagulant strategies were identical in both groups: 80% of patients in each group received DAPT (Aspirin + Clopidogrel), and 20% received a combination of Aspirin and Warfarin (p = 1.000 for both regimens). This suggested that the decision to perform LAD endarterectomy or prescribe postoperative anticoagulation was driven more by individual patient pathology and intraoperative findings than by the conduit used for reconstruction.

Likewise, in a large 10-year study by **Nishigawa *et al.*** [21] involving 188 patients undergoing LAD endarterectomy with LIMA patching, a similar postoperative strategy was used. All patients received DAPT initially, followed by lifelong aspirin. Warfarin was used selectively, especially in cases with long-term atheromatous burden or hemodynamic compromise (AF). Their uniform protocol, along with a reported 30-day mortality of only 1.1% and low MI rates (9%), highlights the safety of combining endarterectomy with patch reconstruction when supported by rigorous postoperative anticoagulation.

Our study found that LIMA patch reconstruction yielded better postoperative outcomes than GSV. The LIMA group had significantly smaller LVEDD (5.0 vs. 5.3 cm; p=0.043) and fewer RWMA (75.0% vs. 47.5% normal; p=0.041), indicating improved ventricular remodeling and regional function. While EF was higher with LIMA (62.0% vs. 58.0%; p=0.264) and MR less frequent (72.5% vs. 52.5% no MR), these differences were not statistically significant. These results suggest LIMA patches may offer superior myocardial recovery and improvement in myocardial function.

Ibrahim *et al.* [16] also supported our results. Among 60 patients, they found that LIMA patching led to more prominent improvements in wall motion and contractility when compared to vein patching, especially in the mid-to-distal LAD territory. Their postoperative echocardiographic analysis showed a reduction in LV dimensions and MR grade in the LIMA group, attributed to better perfusion and myocardial viability.

At six-month follow-up, our study showed that the patency rate of the LAD anastomosis was higher in the LIMA group (80.0%) compared to the GSV group (72.5%). Notably, severe stenosis was observed only in the GSV group (2.5%), while the LIMA group had no cases of severe restenosis. Additionally, good distal run-off was more frequent in the LIMA group (80.0%) than in the GSV group (60.0%), with a *p-value of 0.051*, indicating a near-significant trend favoring LIMA for better patency of LIMA grafting.

Also, **Rezk *et al.*** [17] reported a patency rate of 83.3% in the LIMA group versus 76.7% in the saphenous vein group at 6-month follow-up, assessed by coronary angiography. They also observed fewer significant stenoses and better perfusion quality with LIMA patches, emphasizing the superiority of arterial grafting in maintaining lumen integrity and minimizing restenosis. Furthermore, distal flow was more favorable in the LIMA group in their cohort, echoing our finding of improved distal run-off.

At six-month follow-up, clinical outcomes between the LIMA and GSV groups were largely comparable in terms of rehospitalization (both 12.5%), heart failure incidence (10% vs. 15%), and angina recurrence (30% vs. 20%), with no statistically significant differences noted. However, NYHA functional classification was significantly better in the LIMA group, with 75% of patients classified as Class 2 and only 17.5% in Class 3, compared to the GSV group where only 35% were in Class 2 and 45% were in Class 1 ($p = 0.000$). This indicates a marked improvement in functional capacity among LIMA patients.

These trends were supported by postoperative echocardiographic improvement, which demonstrated significantly greater reductions in LVEDD (−12.96% vs. −8.69%; $p = 0.044$) and greater improvement in ejection fraction (EF) in the LIMA group (+14.29% vs. +9.43%; $p = 0.014$), reflecting superior reverse remodeling and myocardial recovery.

Similarly, **Nishigawa *et al.*** [21] conducted a retrospective study on patients who underwent LAD patch reconstruction using either LIMA or venous grafts. They observed improved EF in the LIMA group, consistent with our findings, and fewer late cardiac events. Their study also noted better wall motion scores and left ventricular function postoperatively in the LIMA group, supporting our conclusion of more effective myocardial recovery.

5. Conclusion

In our study, both techniques used in CABG with LAD reconstruction are safe and widely used, however, the LIMA group showed better myocardial protection with better left ventricular function, and improved ejection fraction postoperatively, and lower rates of postoperative complications such as atrial fibrillation, ST changes, renal, pulmonary, and neurological complications. Also, LIMA group showed trend toward better mitral valve function with less mitral regurgitation and reduced regional wall motion abnormalities.

No significant difference in short-term mortality rates was observed between the two groups, but the LIMA group showed a stronger trend toward better cardiac remodeling and enhanced myocardial contractile function postoperatively. Despite both groups had similar ICU, hospital stay durations and mortality rates, patients in the LIMA group showed better postoperative NYHA classification within 6 months follow up period, indicating improved functional capacity. Collectively, these findings suggest the preference for LIMA grafting as a superior technique for CABG in patients with diffuse coronary artery disease, offering better long-term cardiac performance and lower complication rates compared to saphenous vein patch reconstruction.

6. Study limitations and recommendations

A limitation of our study is the small sample size (80 patients) which limits the extrapolation of our results to a wider population of patients. In addition, the follow-up was limited to 6 months and does not allow the assessment of long-term graft patency and late cardiac events. It is recommended to use LIMA for LAD reconstruction when its length is sufficient for reconstructing the diffusely diseased stenotic segment of the LAD coronary artery and with matched diameter.

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