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Dealing With Diffusely Diseased Left Anterior Descending Coronary Artery Mansoura University Hospital Experience

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Abstract

Background*: Nowadays, due to the rapid advances in PCI, a large number of patients referred for CABG have diffusely diseased LAD. This makes surgery difficult as conventional anastomosis can't be used and reconstructive procedures are needed to achieve complete revascularization. We aimed to demonstrate different surgical techniques to deal with diffusely diseased LAD and when to choose each technique.*

Methods*: Sixty patients who had diffusely diseased LAD and underwent CABG with reconstructive procedures for the LAD in the Cardiothoracic Surgery Department, Mansoura University Hospital between January 2018 and September 2022 were studied. Post-operative assessment was done including post-operative IABP usage, post-operative MI, post-operative arrhythmia, re-exploration, CVA, AKI, [1]mortality in ICU and ECHO and clinical follow up before discharge and three months after surgery.*

Results*: LIMA on-lay patch was the standard technique used. GSV used for reconstructing the LAD when the LIMA was short or the anastomosis was very long followed by LIMA anastomosis to GSV patch. 32 patients had mammary on-lay patch while 14 patients had venous patch. Endarterectomy was done in 13 patients. 5 patients had open endarterectomy with mammary patch, 6 patients had open endarterectomy with venous patch, 2 patients had closed endarterectomy and T-graft was done in 1 patient. There was no post-operative IABP usage, MI, re-exploration, CVA or AKI. Post-operative arrhythmia occurred in 17 patients. Two patients died in the ICU due to chest infection. Patients were satisfied post-operative with improvement of symptoms and ECHO showed satisfactory results.*

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***Conclusion**: Reconstruction of the diffusely diseased LAD can be done using different surgical reconstructive techniques with reasonable CPB and cross clamp time and with very good results.*

***Abbreviations:** PCI, percutaneous coronary intervention; CABG, Coronary Artery Bypass Grafting; LAD, left anterior descending coronary artery; IABP, intra-aortic balloon pump; MI, myocardial infarction; CVA, cerebrovascular accident; AKI, acute kidney injury; ICU, intensive care unit; LIMA, left internal mammary artery; GSV, great saphenous vein; CPB, cardiopulmonary*

***Keywords:** Coronary artery bypass grafting (CABG), LIMA on-lay patch, diffusely diseased LAD, LAD reconstruction*

Introduction Recently, an increasing number of high risk patients with multiple comorbidities are referred for CABG due to the rapid progress in PCI. Among these patients, are those with advanced and diffusely diseased coronary arteries including diffusely complex atherosclerotic lesions (1).

Management of diffuse coronary artery disease (CAD) is considered a surgical challenge as diffuse atheromatous lesions frequently render coronary vessels unsuitable for routine distal grafting. Conventional CABG in these cases may result in incomplete revascularization leading to increased risk of perioperative morbidity and mortality. This group of patients was mostly considered inoperable and was managed medically, until the introduction of reconstructive procedures (2).

Viable large myocardium without necrosis is considered the only indication for coronary bypass in these cases as it is very difficult to find any healthy area for anastomosis. The choice of a surgical method depends on the nature of the coronary artery, and multi-segment plaques and healthy-area intervals facilitate complete revascularization (3).

As the LAD is considered the major blood supply for the left ventricle, aggressive bypass strategies for diffusely diseased LAD territory have evolved including No-touch the plaque techniques and Touch the plaque techniques (4). No-touch the plaque techniques include jumping bypass in the same coronary artery with either multiple grafts, a single graft or a composite graft. Touch the plaque techniques include long-segment anastomosis (1-3cm), patch-plasty (>3cm), endarterectomy with or without patch-plasty (5).

Objective

This study is designed to demonstrate different surgical techniques to deal with diffusely diseased LAD and when to choose each technique in Cardiothoracic Surgery Department in Mansoura University.

Patients and methods

This was a retrospective-prospective clinical non-randomized study which was conducted on 60 patients who had diffusely diseased LAD and underwent CABG with reconstructive procedures for the LAD in the Cardiothoracic Surgery Department, Mansoura university Hospital between January 2018 and September 2022.

Inclusion criteria

All patients of both sex who had diffusely diseased LAD and underwent primary elective CABG, provided that the myocardium was viable.

Exclusion criteria

Off pump CABG.

Ethical approval:

Ethics approval was granted by the Institutional Review Board in Faculty of Medicine, Mansoura University.

Surgical technique:

All patients were subjected to open heart surgery using CPB with cardioplegia and moderate hypothermia aiming for total revascularization. When there was a concomitant lesion, the lesion was repaired after distal anastomosis then proximal anastomosis was done lastly.

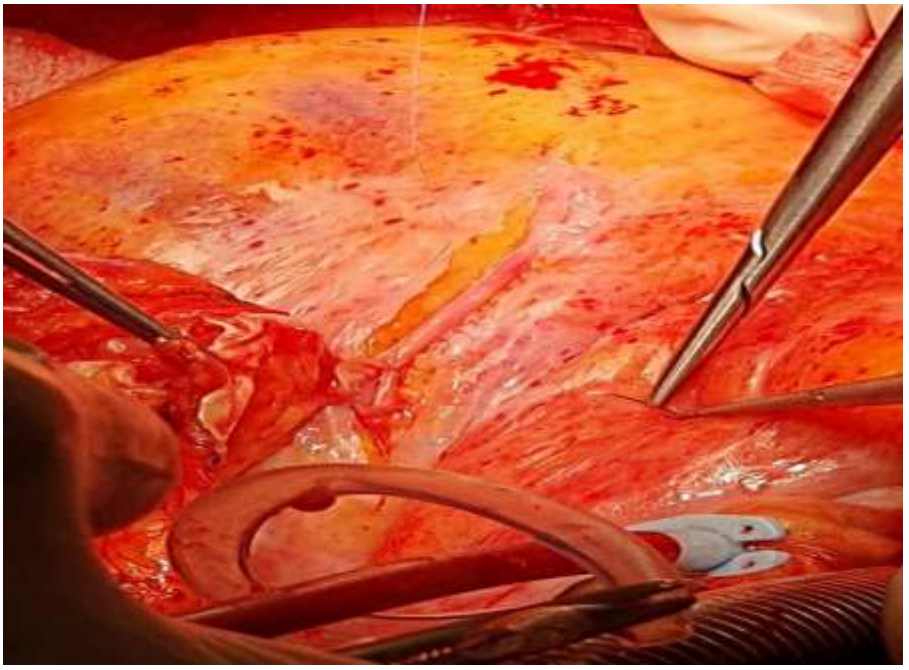
No-touch the plaque technique was used if the LAD had multiple severe stenoses or had critically important side branches before the last stenosis that couldn't be bypassed. It allowed complete revascularization without touching the plaque as the LAD was reconstructed with more than one anastomosis. This method has several techniques. The choice of the appropriate technique was based on the availability of the conduits and whether the operation was elective or emergent.

In case of emergent situation and available conduits, jumping bypass with multiple conduits was used. In elective operations and the available conduits other than LAD were free arterial graft or a short GSV, jumping graft with a composite conduit could be used. If the conduits were limited and the operation was planned, sequential grafting of the LIMA to LAD was appropriate to be done.

Touch the plaque technique was used if there is a longitudinal atherosclerotic plaque obstructing the flow through the LAD. If the plaque had a limited length, a long segment (1-3 cm) anastomosis was done. If the plaque was extensive and the long segment lesion should be opened in full length, the patch-plasty (>3cm) anastomosis was appropriate. The in-situ or free LIMA

was used as onlay patch. If the LIMA was short, a valveless segment of vein patch was used as a hood followed by LIMA grafting.

Figure (1): reconstruction of a diffusely diseased LAD by venous patch followed by LIMA grafting. **A-** Venous patch of the LAD.



B- LIMA grafting after venous patch reconstruction of the LAD.

The LIMA or the saphenous vein patch was opened according to the arteriotomy length. The suture bites were made in a way making lateral plaques exteriorized to anastomosis. This decreased the chance of thrombus formation at the site of anastomosis and provided a smooth surface for the blood flow without turbulence.

Figure (2): reconstruction of a diffusely diseased LAD by mammary onlay patch.

When the LAD was extensively diseased with severe calcification or had an atheromatous plaque totally occluding the lumen, coronary endarterectomy was done. The choice of the type of endarterectomy was based on the ability to achieve an adequate effect with the least possible endothelial trauma. At first, a standard small incision was made in the LAD and the anatomy was assessed. Closed method was used if gentle traction was able to remove the atherosclerotic core. If gentle traction wasn't successful, further extension of the incision was made to help extraction under direct vision (the open technique).

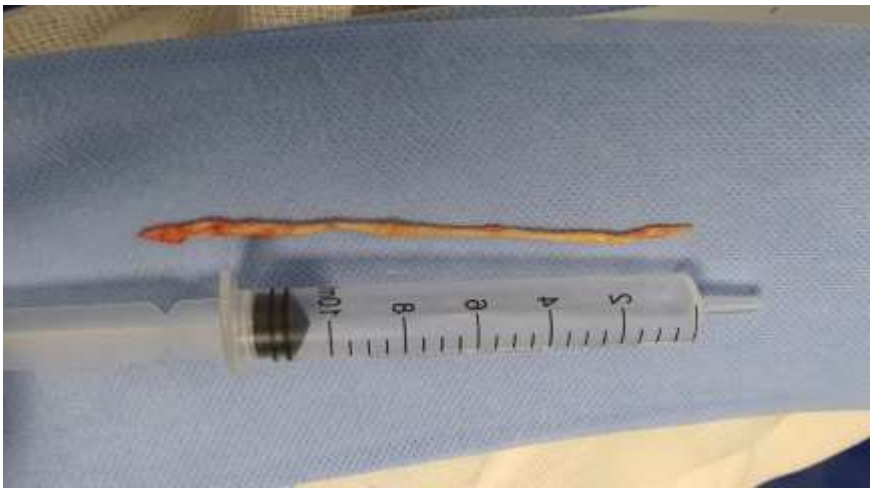


Figure (3): Extraction of a long atheroma after open endarterectomy of the LAD.

Follow up:

Post-operative assessment was done including post-operative IABP usage, post-operative MI, post-operative arrhythmia, re-exploration, CVA, AKI, mortality in ICU and ECHO and clinical follow up before discharge and three months after surgery.

Statistical analysis:

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) statistical software (SPSS, Inc., Chicago, IL, USA) version 22.

Results:

Sixty patients who had diffusely diseased LAD and underwent CABG with reconstructive procedures for the LAD were studied.

Table 1: NYHA functional classification of the studied group.

NYHA staging	No	%
Class I	0	0 %
Class II	0	0 %
Class III	34	56.7 %
Class IV	26	43.3 %

NYHA: New York Heart Association.

All of the patients were symptomatic. 34 patients (56.7%) presented with NYHA staging Class III and 26 patients (43.3%) presented with NYHA staging Class IV.

Table 2: Preoperative left ventricular ejection fraction of the studied group.

LV EF	No	%
Good (> 50%)	33	55.0 %
Fair (35-50%)	26	43.3 %
Poor (<35%)	1	1.7 %

LV EF: left ventricular ejection fraction.

The pre-operative mean left ventricular ejection fraction was 52.53 ± 10.21%. 33 patients (55%) had normal LV EF, 26 patients (43.3%) had mild to moderate LV dysfunction and one patient (1.7%) had severe LV dysfunction.

Table 3: Surgical techniques of LAD reconstruction in the studied group.

Surgical technique	No	%
mammary on-lay patch	32	53.4%
venous patch	14	23.3 %
open endarterectomy with mammary patch	5	8.3 %
open endarterectomy with venous patch	6	10.0 %

closed endarterectomy	2	3.3 %
T-graft	1	1.7%

LIMA was the conduit used for LAD in all cases and GSV was the conduit used for other coronaries. 32 patients (53.4%) had mammary 0n-lay patch while 14 patients (23.3%) had venous patch. Endarterectomy was done in 13 patients (21.7). 5 patients (8.3%) had open endarterectomy with mammary patch, 6 patients (10%) had open endarterectomy with venous patch and 2 patients (3.3%) had closed endarterectomy. T-graft was done in 1 patient (1.7%).

Table 4: Intraoperative IABP insertion and intraoperative mortality in the studied group.

	No	%
Intra operative IABP insertion	1	1.7 %
Intra operative mortality	0	0 %

One patient (1.7%) had intra-operative intra-aortic balloon pump insertion in view of severe left ventricular dysfunction. NO patients died intra-operative.

Table 5: Post-operative characteristics of the studied group.

Post-operative characteristics	No	%
Post-operative IABP usage	0	0 %
Post-operative MI	0	0 %
Post-operative arrhythmia	17	28.3 %
Post-operative re-exploration	0	0 %
Post-operative CVA	0	0 %
Post-operative AKI	0	0 %

Post-operative arrhythmia occurred in 17 patients (28.3%).

Table 6: Patient satisfaction with his life style compared to his life style before surgery in the studied group.

Patient satisfaction	No	%

Yes	58	96.7 %
No	0	0 %
Missed	2	3.3 %

Table 7: NYHA staging post-operative in the studied group.

NYHA staging	No	%
Class I	58	96.7 %
Class II	0	0 %
Class III	0	0 %
Class IV	0	0 %

Table 8: Pre discharge Echo in the studied group.

LV EF	No	%
Good (> 50%)	32	53.3 %
Fair (35-50%)	28	46.7 %
Poor (<35%)	0	0 %
New RSWMA	**No**	**%**
Yes	0	0 %
No	60	100 %

Pre discharge ECHO was done in all patients. The mean post-operative ejection fraction was 51.9 ± 8.28 %. New resting segmental wall motion abnormalities (RSWMA) didn't occur in any patient.

Table 9: Echo 3 months after surgery in the studied group.

LV EF	No	%
Good (> 50%)	40	66.7 %
Fair (35-50%)	18	30 %
Poor (<35%)	0	0 %

New RSWMA	No	%
Yes	0	0 %
No	58	96.7 %

ECHO 3 months after surgery was done in 58 patients as 2 patients died in the ICU. The mean LV EF was 55.21 ± 7.77 %. New RSWMA didn't occur in any patient.

Discussion:

Nowadays, the number of technically challenging and high-risk patients with advanced complex coronary lesions referred for CABG surgery has increased. In these patients, the conventional anastomosis to the distal LAD can't be used as it wouldn't provide satisfactory blood flow to the majority of septal and most of diagonal branches of the LAD and an essential goal in CABG is to achieve complete surgical revascularization. In the past, these patients were mostly considered inoperable and managed medically until the reconstructive procedures have evolved. (6)

In this study, we demonstrate the different surgical techniques for LAD reconstruction and the early and short-term results of these techniques. The study was conducted on 60 patients who had diffusely diseased LAD and underwent CABG with reconstructive procedures for the LAD in the Cardiothoracic Surgery Department, Mansoura University Hospital between January 2018 and September 2022.

LIMA was the conduit we used for LAD in all cases and GSV was the conduit used for other coronaries. 32 patients (53.4%) had mammary 0n-lay patch while 14 patients (23.3%) had venous patch. Endarterectomy was done in 13 patients (21.7). 5 patients (8.3%) had open endarterectomy with mammary patch, 6 patients (10%) had open endarterectomy with venous patch and 2 patients (3.3%) had closed endarterectomy. T-graft was done in one patient (1.7%).

We preferred using the LIMA as on-lay patch for reconstructing the LAD and tried to avoid endarterectomy. When there was a plaque, we exteriorized it in our sutures. We used the GSV as a hood for reconstructing the LAD followed by LIMA grafting only when the LIMA was short. Fitzgibbon et al and Ogus et al were against using GSV patch to reconstruct the LAD (7, 8). On the contrary, other studies support the use of GSV patch for LAD reconstruction (9). We used endarterectomy only when there was severe calcific atheromatous plaque in the LAD with no lumen for anastomosis. Early studies were against LAD endarterectomy showing that it increased post-

operative morbidity and mortality (10). On the other hand, recent studies of LAD endarterectomy showed good results (11).

We favored open endarterectomy over the closed one. Closed endarterectomy is a blind technique and the septal and diagonal branches can be torn off during traction (12). On the contrary, open endarterectomy allow complete removal of the atheromatous core under direct vision which is essential for complete revascularization and better graft patency (13).

In the present study, one patient (1.7%) had intra-operative intra-aortic balloon pump insertion in view of severe left ventricular dysfunction. Christenson et al and Naunheim et al showed that IABP has been widely used during the perioperative period to support patients with preoperative left ventricular dysfunction and low cardiac output syndrome after CABG surgery (14).

We put IABP only after ensuring that all the grafts are in a good position, not under tension, no torsion and complete surgical revascularization was done. We didn't have intra-operative mortality.

In our study, Post-operative arrhythmia occurred in 17 patients (28.3%) in the form of atrial fibrillation (AF). They were given amiodarone which treated the arrhythmia successfully and the patients regained sinus rhythm. In Domaradzki et al, a study conducted on 17 patients who underwent CABG with LAD endarterectomy, 3 patients (18%) developed AF post-operative which was also treated with amiodarone and returned to sinus rhythm (15).

In this study, two cases (3.3%) died post-operative in the ICU due to chest infection. In a study done by Kato et al, 3 patients (2.9%) died in the hospital (16).

In our post-operative evaluation and clinical follow up, NYHA staging and patient satisfaction with his life style compared to his life style before surgery were assessed. 58 patients (96.7%) had NYHA staging class I and were satisfied with their life style compared to their life style before surgery. In a study done by Prabhu et al, 66 patients (84.6%) had NYHA class I, 8 patients (10.3%) had NYHA class II, 3 patients (3.8%) had NYHA class III and one patient (1.3%) had NYHA class IV (17).

Pre discharge ECHO was done in all patients. The mean post-operative ejection fraction in our study was 51.9 ± 8.28 % with no new resting segmental wall motion abnormalities VS 52.53 ± 10.21% pre-operative. In Takanashi et al, the post-operative LVEF was 53.3 ± 11.0% VS 54.4 ± 12.1% pre-operative (18). In Katselis et al, the post-operative LVEF was 50.8 ± 7.28% VS 49.68 ± 9.03% pre-operative (19). There was no significant difference between pre-operative and post-operative LVEF.

ECHO 3 months after surgery was done in 58 patients as 2 patients died in the ICU. The mean LVEF was 55.21 ± 7.77 % with no new RSWMA. 40 patients (66.7%) had normal LVEF VS 33 patients (55%) pre-operative and 18 patients (30%) had mild to moderate LV dysfunction VS 26 patients (43.3%) pre-operative. In Prabhu et al, LVEF was estimated 3 months after surgery.74.4% of the patients had normal LVEF VS 60.6% pre-operative, 24.4% had mild to moderate LV dysfunction VS 34.6 % pre-operative and 1.3% had severe LV dysfunction VS 3.8% pre-operative (17).

Conclusion:

Reconstruction of the diffusely diseased LAD can be done using different surgical reconstructive techniques with reasonable CPB and cross clamp time and with very good results.

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