ORIGINAL ARTICLE

Coronary endarterectomy in the left anterior descending artery in patients with low ejection fraction index: a single-center experience

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Introduction. **Coronary endarterectomy is an old surgical procedure first described by Baily et al. in 1957 and although is not an ideal surgical technique it is the unique tool option for cardiac surgeons in patients with diffuse coronary artery disease. Generally, the left anterior descending artery (LAD) is the most commonly involved artery where the endarterectomy is indicated. The purpose of this study is present our experience of the left anterior descending coronary artery endarterectomy in patients with low ejection fraction in the last 10 years and review the medical literature.** ***Material.*** **In total 42 cases of coronary endarterectomy of LAD in patients with low ejection fractions were studied from January 2008 to February 2020. This is a retrospective and observational study.** ***Results.*** **The mean age of the patients was 55 years (36-78 years), and 58% were male and the mean ejection fraction index was 35 ± 7 (range: 23-45). Also, prior history of myocardial infarction was documented in 23 (54.76%) patients and the 60% had more than one cardiac risk factor. The hospital mortality was 0% and there was not postoperative myocardial infarction.** ***Conclusions.*** **The on-pump coronary endarterectomy using the open technique and on lay-patch grafting using the internal thoracic artery for a diffused diseased LAD provides satisfactory clinical outcome, being a reasonable option with acceptable mid-term results without forget that the postoperative antiplatelet regimen has a key role in the improving of clinical results and graft patency.**

Key words: **CABG; Coronary endarterectomy; Left anterior descending coronary artery; Left internal mammary artery patch**

Introducción. **La endarterectomía coronaria es un antiguo procedimiento quirúrgico descrito por primera vez por Baily y cols. en 1957 y aunque no es una técnica quirúrgica ideal, es la única opción para los cirujanos cardíacos en pacientes con enfermedad coronaria difusa. Generalmente, la arteria descendente anterior (DA) es la arteria más comúnmente afectada donde está indicada la endarterectomía. El propósito de este estudio es presentar nuestra experiencia de endarterectomía de la DA en pacientes con fracción de eyección baja en los últimos 10 años y revisar la literatura médica.** ***Material.*** **En total se estudiaron 42 casos de endarterectomía coronaria de DA en pacientes con baja fracción de eyección desde enero de 2008 hasta febrero de 2020. Es un estudio retrospectivo y observacional.** ***Resultados.*** **La edad media de los pacientes fue de 55 años (36-78 años), el 58% eran varones y el índice medio de fracción de eyección fue 35 ± 7 (rango: 23-45). Además, se documentaron antecedentes de infarto de miocardio en 23 (54.76%) pacientes y el 60% tenía más de un factor de riesgo cardíaco. La mortalidad hospitalaria fue del 0% y no hubo ningún infarto de miocardio postoperatorio.** ***Conclusiones.*** **La endarterectomía coronaria con bomba utilizando la técnica abierta y el injerto de parche de colocación utilizando la arteria torácica interna para una DA con enfermedad difusa proporciona un resultado clínico satisfactorio, siendo una opción razonable con resultados aceptables a mediano plazo, sin olvidar que el régimen antiplaquetario posoperatorio tiene un efecto clínico satisfactorio, papel clave en la mejoría de los resultados clínicos y la permeabilidad del injerto.**

Palabras clave: **Revascularización coronaria; Endarterectomía coronaria; Descendente anterior; parche arteria mamaria interna izquierda.**

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Currently cardiac surgeons are having a hard time facing a complex myocardial revascularization in an advance age patient with comorbid conditions like, diabetes mellitus, renal insufficiency, peripheral vascular diseases and previous percutaneous coronary interventions (PCI). The progressive application of percutaneous coronary interventions (PCI) to achieve myocardial revascularization has contributed to the referral of patients with distinctly less attractive anatomic substrates for surgery and more complex coronary anatomy. Diffuse coronary artery disease can be defined as "consecutive or longitudinal" and "complete or partial" obstruction in coronary vessels and for these pathology complete revascularization of coronary arteries and mainly of left anterior descending artery (LAD) which plays a very important role in terms of postoperative and long term outcomes, is the most important objective in coronary artery bypass grafting. Incomplete CABG does not affect the immediate mortality rate, but the incidence of arterial reoperations with significant obstructions in vessels, which irrigate the viable myocardium, negatively affects long-term cardiac events. These patients have greater recurrence of angina, worse performance in stress tests and a greater work absenteeism rate and require a greater number of re-interventions, besides the better survival rate of completely grafted patients [1-3].

Because of this increasing number of patients with a diffuse coronary artery lesions, around 25% of them cannot be managed with standard coronary artery bypass grafting (CABG) [4]. Therefore, several techniques including coronary endarterectomy have been proposed to expand surgical possibilities [5,6]. Endarterectomy is the removal of the atheromatous plaque, dissecting and separating the external media and adventitia layers, thus restoring the lumen to the artery. In patients with diffuse coronary disease, characterized by long segments impaired by atherosclerosis, endarterectomy of the coronary arteries (ECA) is often necessary to perform complete CABG or to facilitate anastomosis of seriously calcified arteries [7]. A conventional anastomosis placed distally in a diffusely diseased vessel such as the left anterior descending artery (LAD) may leave a large area of myocardium supplied by large side branches unrevascularized, which defies the principle of CABG aiming at complete revascularization.

The purpose of this study is present our experience of the LAD CAD in patients with low cardiac output in the last 10 years.

MATERIAL

This was an observational transverse analytical and In a retrospective review of clinical records, we analyzed data on 42 patients with diagnosis of ischemic cardiomyopathy and low ejection fraction whom underwent on pump coronary artery bypass grafting and extended left descending coronary artery endarterectomy to get a functional complete myocardial revascularization from January 2008 to February 2020. All of the procedures were performed by one single medical team from the thoracic and cardiovascular department at our institution and all cases were reviewed at a peer review conference before being accepted for surgery.

We followed the recommendations from the American Heart Association (AHA) [8], European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS) [9] guidelines for myocardial revascularization to choose the best treatment for the patients with coronary artery disease.

Hospital records were reviewed for patient's demographic characteristic, preoperative status and co-morbidities, intraoperative variables, and postoperative course.

We consider indications for LAD endarterectomy the same that Trehan and Mishra [10] established in 1999 that are the following: i) chronic total occlusion of the LAD; ii) multiple obstructions in the LAD; iii) diffusely diseased LAD with atherosclerotic extending into major side branches; iv) heavily calcific plaque impending suturing of bypass graft to the coronary vessel; and v) soft atherosclerotic plaque for fear of sutures disrupting the plaque and causing distal embolization. The first three indications were often anticipated from the coronary angiography and confirmed during surgery.

In other words, the endarterectomy was considered just for cases that were described above in which during the surgical procedure the bypass to distal vessels of acceptable quality and at least 1.5 mm in diameter was not otherwise possible. For the purpose of this paper, we define a long or extended endarterectomy for LAD when it was more than 30mm. We include just patients with an ejection fraction equal or lower to 45% that was calculate from single ventricular angiography by modified Simpson method or by transthoracic echocardiography. Surgery was considered urgent if the patient was treated as soon of possible after making the diagnosis. Emergent operation was defined as the condition that prompted immediate operation within 24 hours from diagnosis. For definitions of mortality and morbidity, standard guidelines were used [11]. An early event referred to any event within the first 30 postoperative days or during the entire hospital stay.

Operative management

All patients were operated on pump CABG surgery with aortic, two stage single right atrial cannulation and left vent using a standard cardiopulmonary bypass technique with mild to moderate hypothermia (28-320C). Myocardial protection was achieved with anterograde and retrograde cardioplegia. After median sternotomy, simultaneously left internal mammary artery skeletonized graft and saphenous vein graft were harvested. To perform the endarterectomy, we used the open technique. The most suitable soft spot from the diseased coronary vessels is identified and posteriorly and arteriotomy is done, and failure to pass 1mm coronary probe through the arteriotomy confirmed the need for endarterectomy that consist in a longitudinal arteriotomy on the coronary vessels beyond the limits of the atheromatous plaque and the atherosclerotic plaque is lifted off with fine forceps and a spatula under direct vision leaving free of plaques the septal and diagonal branches involved (**Fig.1**) . The proximal end of the endarterectomy was distal to the most proximal lesion to prevent competitive flow through the native coronary artery. In case of intimal lesion this was tacked with 8-0 polypropylene sutures to prevent flap formation. Then, an on-lay patch anastomosis to the LAD derived from the internal thoracic artery or saphenous vein graft, which is opened to the appropriate

length is performed. Alternatively, a longitudinally opened saphenous vein patch is sewn in place of the arteriotomy an then the left internal thoracic graft is anastomosed to the vein patch [12-14]. Also, in some cases we used injection of cardioplegia solutions in the plane between the adventitia and the atherosclerotic core to facilitate the plaque extraction [15]. The same open endarterectomy technique was employed in the other coronary artery using a saphenous vein graft in case it was required to get a complete myocardial revascularization, defining this as bypass grafting to all majors branches which had a significant stenosis (> 50 %).

Patients followed the regular protocol of management of the postoperative care of patients whom were performed the CABG [16] and received unfractionated heparin infusion started in the intensive care unit on day 0 typically after 6 hours or as soon as chest tube output is considered not important. Also, the patients begin a dual antiplatelet protocol [17], 75mg of clopidogrel and 100mg of aspirin per day. Clopidogrel was discontinued 1 year after the operation and aspirin was continued indefinitely.

Echocardiography was done to all patients routinely prior discharge. Following discharged, patients were followed up in outpatient clinic one week following discharged and then one month after.

Statistical Analysis

Statistical analyses were performed using SPSS® Statistics 19.0 software. Normally distributed continuous variables are expressed as mean ± SD, and skewed continuous variables are expressed as frequencies and percentages. Preoperative and postoperative ejection fraction was compared using the paired Student t test less than 0.05 were considered statistically significant.

RESULTS

Demographic, Clinical and Risk Factors Characteristics

Demographic, clinical and risk factors characteristics are summarized in **Table 1**. Forty-two patients enrolled in the study. Patient's mean age was 55 years, ranging from 36-78 years and 58 percent were male. Most common cardiac risk factors were diabetes mellitus (66.66%), hypertension (52.38%), and smoking (42.85%). More than half of the patients (54.76%) has past medical history of myocardial infarction and just three patients (7.13%) have been managed with coronary angioplasty previously. All the study of the patients has a left ventricular disfunction, 50% patients with ejection fraction between 30-34 % and 26 % patients has ejection fraction below 30%. Majority of the patients (72%) has functional class NYHA class II-III. The surgical risk was calculated through EuroSCORE, being low in 23% of the patients (1.2% probability of mortality) intermediate in 63% (3% probability of mortality) and high risk in 14% (9.9% probability of mortality).

Table 1. Demographic, Clinical and Risk Factors Characteristics

VARIABLE	n (%)
Number of patients	42
Age (years)	
mean	55
range	36-78
Gender	
male	24(58)
female	18(32)
Risk factors	
Obesity	21(50.00)
Hypertension	22(52.38)
Diabetes Mellitus	28(66.66)
Dyslipidemia	10(23.80)
Smoking history	18(42.85)
Cerebrovascular disease	4(09.52)
Peripheral arterial disease	6(14.28)
Chronic Renal Insufficiency	2(04.76)
COPD	2(04.76)
Family history	14(33.33)
Previous Myocardial Infarction	23(54.76)
Previous PCI	3(07.14)
NYHA functional class	
I	4(09.52)
II	16(38.09)
III	14(33.33)
IV	8(19.04)
LVEF	
35-45%	10(23.80)
30-34%	21(50.00)
25-29%	10(23.80)
< 24%	1(02.30)
Surgical indication	
Stable Angina	15(35.71)
Instable Angina	10(23.80)
Post-AMI	13(30.95)
Heart Failure	4(09.52)

COPD: Chronic Obstructive Pulmonary Disease; PCI: Percutaneous Cardiac Intervention; LVFE: Left Ventricular Ejection Fraction; AMI: Acute Myocardium Infarct

Operative Data

Operative data are shown in the **Table 2**. Most procedures were performed in an elective basis (95%). The mean operative time was 340 ± 91 minutes, the mean cardiopulmonary bypass time was 160 ± 45 minutes, and the mean aortic cross-clamp time was 90 ± 17 minutes. The majority of patients had three coronary grafts (61.90%), four coronary grafts in 23.08% of the patients and 14.28% just two coronary grafts. The mean number of grafts per patient was 3 ± 1. The mean size of the endarterectomy of the LAD was 8.8 ± 2.5 cm, and 38 patients (90.47%) the on-lay patch with left internal thoracic artery was performed. In fifteen patients beside LAD endarterectomy were required realized endarterectomy in the right coronary artery in eleven patients (26.19%), 3 patients (7.1%) in the obtuse marginal artery and one patient required endarterectomy in the LAD, right coronary artery and obtuse marginal artery.

Table 2. Operative Data

VARIABLE	n (%)
Status of the procedure	
Elective	38(90.47)
Emergent	04(9.53)
Urgent	00
Aortic cross-clamping time (min)	90 ± 17
Cardiopulmonary bypss time (min)	160 ± 45
Left Main Disease	12
Number of grafts	3 ± 1
2	06(14.30)
3	26(61.90)
4	10(23.80)
5	00
Territory of Endarterectomy	
LAD	42
LAD + RCA	11
LAD + OM	03
LAD + RCA + OM	01

LAD: Left anterior descending; OM: Obtuse marginal; RCA: Right coronary artery.

Postoperative Data

The mean length of stay in the intensive care unit was 2 days (range 4 ±2 days) and the mean hospital stay was 7days (range 10 ± 3 days). The hospital mortality was 0%.

Morbidity was 30.95% % (13 patients). Five patients developed low cardiac output syndrome, 7 patients showed atrial fibrillation and 1 renal failure. The postoperative data are shown in **Table 3.**

From the 42 patients discharged from the hospital, there was 1 late death, due to anterior myocardial infarction secondary to thrombosis in the LAD (thirty days after discharged). The mean follow-up period was 12 ± 3 months during which the 90% of the patients were angina free and the 80% were in Canadian Class I.

DISCUSSION

In the current era more patients referred for CABG carry a higher risk profile and advanced age that provoke a more complex and diffuse coronary artery disease. The objectives of the CABG are getting a better quality of life and better survival and in order to obtain these results, all viable myocardium must be revascularized to get a complete functional revascularization that consist in treat all coronary segments with 50% diameter stenosis supplying viable myocardium [18]. In patients with diffuse coronary artery in conjunction with reduced left ventricular function remains a surgical challenge and, in an attempt to improve the outcome for this set of patients and get a complete functional revascularization (that is one of the most important factors that influence long-term mortality and morbidity), one must be more aggressive and undertaken coronary endarterectomies (when these are indicated). Specifically, in the LAD that is the most common coronary artery affected for a diffuse coronary artery disease in particular, a simple anastomosis to the distal part of the LAD does not achieve functional complete revascularization of the myocardium supplied by the branches affected by a diffuse atheromatous lesion, so in these cases coronary endarterectomy can be the only and effective surgical option.

Coronary endarterectomy preceded the introduction of CABG as a surgical option for coronary artery disease. Baily et al. [19] were the first to described coronary endarterectomy as a treatment against coronary artery disease without using extracorporeal circulation. However, its accompanying morbidity and mortality overshadowed its success in angina relief. In particular, endarterectomy of the LAD was considered technically difficult [20-22] and it initially appeared to be accompanied by high operative mortality and perioperative myocardial infarction [23-26]. Hence, coronary endarterectomy indications were restricted to those patients with severe and diffuse CAD [27]. Since that time, several publications have shown that coronary endarterectomy either with on-pump CABG [28,29] or with off-pump CABG can be safely performed [30,31] and is associated with favorable long-term outcomes [32,34].

Most of the patients with diabetes, hyperlipidemia, hypertension, obesity, chronic renal insufficiency, connective tissue diseases and multistented coronary arteries have diffuse atherosclerosis lesions in the coronary territory. All of these pathologies accelerate coronary arteriosclerosis differently. Diabetes mellitus increase the incidence of CAD two to four times as much and accelerates the nature of the atherosclerosis. The nature of CAD in diabetic patients is clinically challenging because it causes an extensive and diffuse multivessel involvement. Hyperglycemia is directly related to atherosclerotic development, progression, and instability due to induced endothelial dysfunction, abnormalities in lipid me-

Table 3. Postoperative Data

VARIABLE	
Mechanical ventilation (hours)	18 (0 - 48)
LOS in ICU (days)	2 (2-4)
In-hospital stay (days)	7 (3-10)
Mortality	
Early	0 (0%)
Late	1(2.38%)
Complication	
Perioperative MI	0 (0%)
Mediastinitis	0 (0%)
Low cardiac output	5 (11.90%)
Pneumonia	0 (0%)
Renal failure	1(2.38%)
Neurological	0 (0%)
Atrial Fibrillation	7(16.66%)
Reoperation for bleeding	0 (0%)

ICU= Intensive care unit; LOS= length of stay

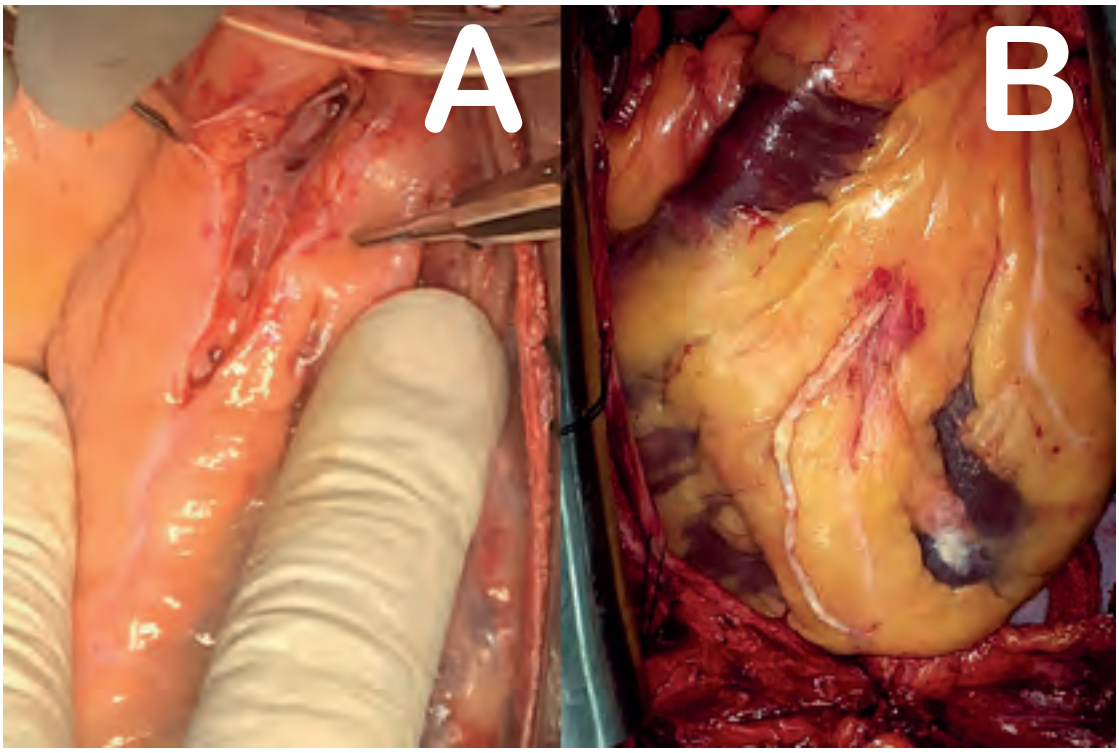

Figure 1. A) Arteriotomy and endarterectomy in left anterior descending, B) 13 cm longest plaque extracted from the left anterior descending artery.

tabolism, and systemic inflammation. In the diabetic patients the coronary artery bypass has better long-term survival and freedom from reintervention no matter the severity of the CAD because is the only strategy that could offer a functional complete revascularization [35].

Hypercholesterolemia is other important risk factor for the development of premature CAD. Cholesterol levels and CAD show a strong and linear relationship, whereas cholesterol levels even in normal range may inhibit endothelium-dependent vasodilatation in all arterial bed.

The pathogenesis of atherosclerosis in the obese population can be related to metabolic syndrome associated with insulin intolerance and dyslipidemia, which cause endothelial dysfunction with decreasing nitic oxide production.

In our report more than the 50% of patients present diabetes mellitus, obesity, and hypertension that all together represent the metabolic syndrome that is the principal actor to cause endothelial dysfunction that provoke decrease the capacity of nitic oxide synthetase enzyme and depleted nitric oxide, overexpression of growth factors and muscular proliferation that accelerate atherosclerosis in all arterial territories, and the involvement of coronary arteries can be very extensive and diffuse with either serious jumping stenosis or long segment narrowing with/without occlusion.

There are two different approaches to perform coronary endarterectomy: a closed and an open one. Nevertheless, it is not clear which is the optimal technique [12]. In the closed technique, a smaller arteriotomy is needed to remove the atherosclerotic plaque by applying gentle steady traction on it proximally and distally [36]. Two concurrent arteriotomies can also be used for coronary endarterectomy to make the procedure faster and shorten ischemic time [37]. The closed technique is shorter and the anastomosis of the graft is easier [38], but occurrence of the snowplow effect – occlusion of the distal LAD and its side branches – due to insufficient endarterectomy is more possible [39]. Despite gentle traction applied on the proximal part of the atheromatous core in LAD, its distal part in diagonal branches and septal perforators may be torn off forming an intimal flap. As a result, occlusion of the lumen may occur distally due to a thrombus or dissection. On the contrary, when the open approach is applied, a longitudinal arteriotomy is performed on the coronary vessel beyond the limits of the atheromatous plaque and the atherosclerotic plaque is lifted off [12]. Then, an on-lay patch anastomosis to the LAD derived from the internal thoracic artery or saphenous vein graft, which is opened to the appropriate length, is performed [14]. Alternatively, a longitudinally opened saphenous vein patch can be sewn in place of the arteriotomy and then the left internal thoracic graft can be anastomosed entirely to the vein patch. Although this method takes more time, the atheromatous plaque is removed under direct vision, so the openings of the side branches and of the distal end of the LAD can be directly checked. Moreover, if a dissection of the intima of the distal LAD happens, it can be fixed to secure the distal flow.

According to the results of Nishi's study [40], comparing the open method with the closed one, open endarterectomy is superior to the latter. Patients who underwent open endarter-

ectomy had a lower, although non-significant perioperative mortality. However, this group was associated with statistically significantly better long-term results. The five-year survival rate was 90.7% in the group of open endarterectomies, whereas it was 74% for the group of the closed technique. Moreover, the open method was also associated with better results in terms of morbidity, as 85.2% of patients openly endarterectomized compared to 76.6% of patients endarterectomized with the closed method suffered neither from angina nor from congestive heart failure during the follow-up. The optimal technique for performing coronary endarterectomy remains controversial and despite recent studies have shown that coronary endarterectomy without use of cardiopulmonary bypass can be perform safely, we preferred to use in all of our patients, on-pump coronary endarterectomy using the open technique no matter this technique takes more time, but has the benefit to avoid the snowplow effect, intimal flap formation, residual obstruction, and using on pump technique we prevent stress in cardiac team, the procedure is make easily and the quality is guaranteed.

Although the efficiency of coronary endarterectomy is doubted [41-45], it constitutes an additional treatment in cases of diffuse CAD and severe calcification of coronary arteries [27]. In cases of diffuse CAD, affected side branches (diagonal and septal branches) obtain sufficient blood flow when endarterectomy is efficiently performed. However, conventional CABG with a distal anastomosis to LAD itself is not sufficient to supply blood to side branches and residual angina is possible. Moreover, neither intense calcification nor soft atherosclerotic plaques are contraindications to obtain a satisfying anastomosis after coronary endarterectomy. On the contrary, if a simple anastomosis was performed in the latter case, plaque rupture resulting in emboli formation would be possible. Therefore, coronary endarterectomy has evidence when diffuse atherosclerosis affecting side branches exists and when severe calcifications of the LAD prevent the performance of a simple anastomosis of the left internal thoracic artery graft to the LAD. Preoperative coronary angiographic findings such as luminal diameters smaller than 1mm, obstruction and pinching of the side branches in multiple sites, and an uneven and diffuse thread-like appearance can constitute indications for endarterectomy [37]. However, the final decision to perform endarterectomy is made intraoperatively when the aforementioned findings are noted.

In selected patients with diffuse coronary artery disease and extensive settings, coronary endarterectomy is undertaken as an alternative for CABG. Notwithstanding, the 2011 ACC/AHA Guideline for Coronary Artery Bypass Graft Surgery [9] and 2018 ESC/EACTS Guideline on myocardial revascularization have no reference to the clinical recommendation of coronary endarterectomy due to the absence of randomized controlled trials [8]. Thus, the authentic role of CE has generated keen interests, controversy and widespread discussion.

The role of antiplatelet therapy to improve long-term graft patency after coronary surgery is well known in the literature. While aspirin administration is in the Class I indication after CABG [17], the benefit of concomitant clopidogrel is a controversial issue. After coronary endarterectomy, strict antiplatelet and anticoagulation management is required because the lack of the endothelium leads to coagulation cascade activation by the subendothelial material exposed to blood flow [36,46,47]. However, no standard anticoagulation protocol after coronary endarterectomy exists [12]. Heparin infusions followed by warfarin for several months are recommended by several authors [48]. Postoperatively, intravenous heparin, 100mg of aspirin per day, and warfarin are administered. The systematic administration of heparin is continued until warfarin is effective (meaning an international normalized ratio between 2.0 and 2.5). After 3 months, warfarin is discontinued. A preoperative or intraoperative dose of clopidogrel followed by postoperative aspirin and clopidogrel administration is another anticoagulation scheme used after coronary endarterectomy48. In our report we use heparin infusion that is started in the intensive care unit and started the administration of aspirin (100mg) and clopidogrel (75mg). the aspirin is continued indefinitely and the clopidogrel is discontinued after six months. We did not consider warfarin because is more difficult its use for our population and commonly in our entity is out of market. The use of just aspirin and clopidogrel have had a good outcome in our patients, and the only death during the study was due that the patient did not followed the instructions to take the antiplatelets medications.

In our study, we used the LIMA to anastomose with LAD in 100% of our cases. Previously, the internal mammary artery (IMA) has been utilized cautiously as a conduit to an endarterectomized vessel, but many authors have shown satisfactory early and late clinical results with luminal patency of IMA to an endarterectomized vessel compared to great saphenous vein conduit [49-52]. Acute MI due to acute graft occlusion is a noteworthy complication following CE, in our study the incidence of acute MI was 0% compared with other studies that the incidence is about of 1.5-19% [49,53-58].

Residual disease due to incomplete revascularization is associated with high operative and late mortality after CABG. Perioperative and late myocardial infarction rates and reoperation rates are also increased after incomplete revascularization. Moreover, when revascularization is incomplete, symptoms are not completely relieved and there is an adverse impact on left ventricular functional reserve. All these deleterious effects of incomplete revascularization on survival are more intense when the LAD is incompletely revascularized [37]. Coronary endarterectomy, particularly of the LAD, can successfully be performed with diffuse CAD [47,49], and in occasion the right coronary artery (RCA) or branches from the circumflex artery also must be endarterectomized following the same open or close technique using saphenous vein graft in order achieve complete revascularization and prevent all the aforementioned deleterious effects. Excellent short-term clinical and angiographic results accompany RCA endarterectomy according to Erdil et al. Moreover, no additional morbidity or mortality is associated with RCA endarterectomy when compared to non-endarterectomized RCAs during RCA bypass [60].

Overall, hospital mortality rate ranges from 2.0% to 6.5% in international literature. However, the mortality after CABG along with endarterectomy appears to be higher compared to that after conventional CABG because of the associated comorbidities and risk factors rather than the endarterectomy itself. In our study despite that fifteen patients (35.71%) need

more than just the LAD endarterectomy (double endarterectomy 14 patients and triple endarterectomy 1 patients) the hospital mortality was 0% and no postoperative myocardial infarction like was described above.

In conclusion, currently we must think about how to treat patients with diffuse coronary disease seem to be mandatory. Principle goal in CABG is to achieve complete functional myocardial revascularization. In this retrospective observational study, we demonstrated that on-pump CE using the open technique and on lay-patch grafting using the internal thoracic artery for a diffused diseased LAD provides satisfactory clinical outcome, being a reasonable option with acceptable mid-term results without forget that the postoperative antiplatelet regimen have a key role in the improving of clinical results and graft patency. Although diffuse atherosclerosis is severe enough, it is uncommon to render any patient unsuitable for surgery if we do not forget that the coronary endarterectomy is our friend and not our enemy.

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