

# Outcome of CABG with or without Coronary Endarterectomy in Bangladesh: A Retrospective Cohort Study

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## Abstract:

**Objective:** In this review, we assess the outcome of surgical revascularization technique, coronary artery bypass grafting (CABG) with or without coronary endarterectomy (CE) for patients with diffuse coronary artery disease in a single surgeon's practice.

**Methods:** We retrospectively reviewed 2189 patients who experienced OPCABG with or without CE between January 2009 and December 2016. The following variables were compared in this study- Intubation time, ICU stay, Postoperative MI, Arrhythmia, renal impairment, stroke and ICU mortality.

**Results:** Of 2189 patients, 1000 patients required coronary endarterectomy in addition to OPCABG. Initially, there was a higher mortality rate and incidence of postoperative blood transfusion in the group of patients who had CE in addition to CABG, with no significant difference in other outcomes. But

postoperative use of Heparin, Warfarin and Double antiplatelet agent was associated with decreased mortality significantly in our study. In comparison to other group, the patients in the combined CE with CABG group had a higher incidence of male sex, past MI, and poor left ventricular function. However, emergency CABG, renal impairment, poor left ventricular function, and also peripheral vascular disease were associated with higher mortality in both group of the patients; CE was not a predictor of postoperative mortality.

**Conclusions:** Total surgical revascularization is attainable and accomplishes, when Coronary endarterectomy is performed in addition to Off-pump coronary artery bypass graft in patients when there is no other choice for satisfactory revascularization.

*Key words:* Endarterectomy, Coronary Artery Disease, Coronary Artery Bypass Grafting.

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## Introduction:

In the late 1950s, Coronary endarterectomy was at first described as a surgical technique for myocardial revascularization<sup>1</sup>. Endarterectomy is the removal of the atheromatous plaque through a plane between the external

media and adventitia layers, along these lines restoring the lumen to the supply distal part of artery. In patients with diffuse coronary artery disease, coronary endarterectomy is frequently performing to attain complete myocardial

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revascularization. Diffuse coronary artery disease can make sufficient surgical treatment troublesome or even forestall it completely. In these cases, conventional CABG does not provide a satisfactory myocardial revascularization, bringing it about incomplete CABG<sup>1</sup>. However, inadequate revascularization does not influence the quick death rate, but rather increase the incidence of reoperations with significant obstruction in vessels, which influences the long term cardiac function. These patients have repeated attack of angina, more frequent work absence rate, poor performance in stress tests and also need an early coronary re-intervention, but complete CABG group of patients have better survival rate<sup>2,3,4</sup>.

Ischemic heart disease (IHD) patients, who are referred for CABG (coronary artery bypass graft) surgery are getting more complex with multiple comorbidities, like hypertension, diabetes, renal impairment, and peripheral artery disease, also a big portion of this group of patients have experienced previous Coronary intervention angioplasty. Subsequently, patients referred for CABG regularly have progressed and diffuse coronary artery disease, which has made complete surgical revascularization more difficult. This study evaluates the consequences of coronary endarterectomy (CE) in a single surgeon's practice at our institute and to provide details regarding our treatment strategies for patients experiencing diffuse coronary artery disease.

#### **Methods:**

From January 2009 to December 2016, 2189 patients were evaluated to CABG with or without CE in a single surgeon's practice. We review the outcome of study population by survival rate, Post-operative MI, post-operative cardiovascular and neurological event, re-intervention, hemodynamic instability, NYHA class and Canadian class for angina were researched. However, there was a measurable distinction in regard to the previous infarcted area is shown in Table-1 with the pre-operative variables from the patients. During this study, every patient was reached either during OPD visit (outpatient department) or by phone call and data was gotten through the reactions to a data sheet.

#### **Surgical procedure:**

All procedures were performed through a standard median sternotomy. After the conduits (internal mammary artery, radial artery, and the saphenous vein) were harvested, heparin was used to maintain an ACT (Activated clotting time) more than 400 seconds. Almost all the operations were performed off pump CABG and a few cases required the assistance of cardiopulmonary bypass (CPB), using a membrane oxygenator, utilizing the surgical procedures to

acquire the graft<sup>4</sup>. We utilized mechanical stabilizers, the compression type and suction type to immobilize the target coronary artery during grafting. Final decision to endarterectomize a coronary artery was made intraoperatively and it depends on technical contemplations. Coronary endarterectomy was considered, when the targeted artery was completely or almost impeded with long segment stenosis and severely calcified plaques.

Utilizing the closed methods, coronary endarterectomy was performed manually by slow sustain and continuous traction of atheromatous plaque with the aid of Ring Forceps, trailed by reproduction with anastomosis with pre-planned graft. The CE was performed when localized lesion blocked a sufficient distal stream, distal diffuse lesion or multi-segmental lesion; or when a calcified or extremely thick plaque burst, making anastomosis troublesome or hindering the stream. The arteriotomy was approximately 8-10mm long, however that was extended out for another 5mm in few cases, if complete removal of the plaque was not feasible. Exceptionally sensitive ring forceps were utilized to build up a plane between the media lamina and the atherosclerotic plaque. Much consideration was paid to the entire expulsion of the distal segment but proximal traction of the plaque was avoided; because of the danger of competitive flow loss between the graft and the native artery that may steal blood flow through the graft. To ensure complete expulsion of the distal atheroma, the atheromatous plaque carefully inspected for a smooth distal taper end (Figure-1). In addition, back flow of blood from the distal vessel following extraction of the atheroma is a consoling indication of adequate removal atheromatous plaque and that is special feature in OPCABG endarterectomy. Every cases were performed with single arteriotomy incision and longest atheroma was 14cm in size (Figure-1) in our study.

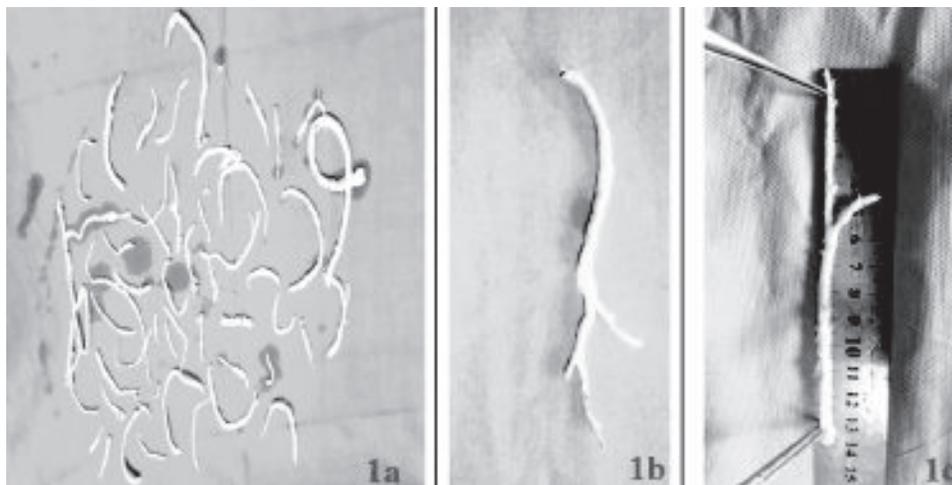
Postoperatively, every patient was closely observed in ICU with ECG, ABG Analysis, FBC, S. creatinine, LFT, Chest X-ray and also CK-MB was performed where indicated. Every patient got Heparin bridging to Warfarin from the first post-operative day for six months and also used oral combination of Clopidogrel with Aspirin (75 mg) to anticipate acute thrombosis at the graft and in the endarterectomies artery. Usually Warfarin started with 10mg daily for first three post-operative days followed by 5mg till 6 months post-operatively and dose adjusted according to INR (Targeted INR 1.5-2.5).

#### **Results:**

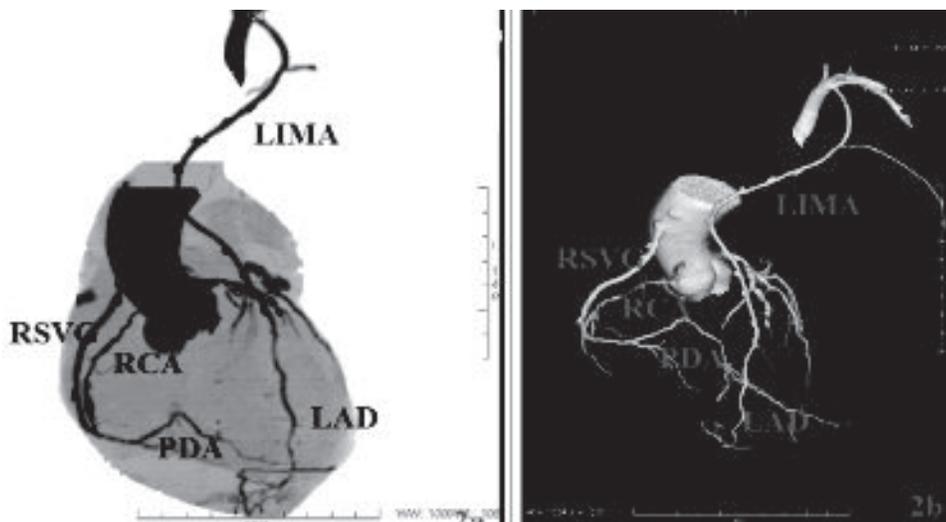
Total 2189 number of patients were studied in this review. However, 1189 patients underwent only CABG (Group-1) and 1000 patients underwent CE with CABG (Group-2) (Figure-3). Twelve hundred endarterectomies were performed in Group-2, shown in a pie chart (Figure-4).

16.5% of the patients required multiple endarterectomies (1.2 endarterectomies per patient). Of the 1200 endarterectomies, 75.1% were performed in the left coronary territory and 24.9% were performed in the right coronary territory. The mean number of graft were  $3.02 \pm 0.15$  in only CABG group and  $3.28 \pm 0.25$  in CE with CABG group. The mean follow-up period was  $8.5 \pm 3.5$  months (between of 6 to 24 months). The quantities of graft and endarterectomies are appeared in Table 2. There were 18.5% conversions to on-pump CABG using cardiopulmonary bypass in CE with CABG Group but only 2.78% conversions to on-pump CABG in only CABG Group. Post-operative ICU mortality rate was 1.68% in Group -1, and 1.8% in Group -2. There were no intra-operative mortalities in this study.

A mean of  $1.5 \pm 0.5$  units of blood was transfused postoperatively in CE with CABG group, which is more than only CABG group, where  $1.2 \pm 0.5$  units of blood was transfused. In only CABG group, 91% patients were in regular follow-up, whereas 92.7% patients were in regular follow-up in CE with CABG group. At median follow-up of 2.5 years, 91.78% and 88.5% of patients were angina free in Only CABG group and CE with CABG group respectively. The rest of the postoperative characteristics including mortality and morbidity are listed in Table- 3. Only 1.2% patient of CE with CABG group presented with chest pain and was readmitted and, despite the fact that there was no electrocardiographic confirmation of acute myocardial ischemia, a cardiac catheterization was done which showed



**Fig.-1:** Photograph illustrate coronary atheroma. (a) Bunch of Coronary atheroma; (b) Tapper end of atheroma indicates complete endarterectomy; (c) Longest atheroma (14 cm) extracted from RCA.



**Fig.-2:** Postoperative CT Angiogram following CE with CABG(a) and (b); Patent distal anastomosis graft-LIMA to LAD; RSVG to PDA graft; (A 14cm long atheroma was extracted from RCA of this patient).

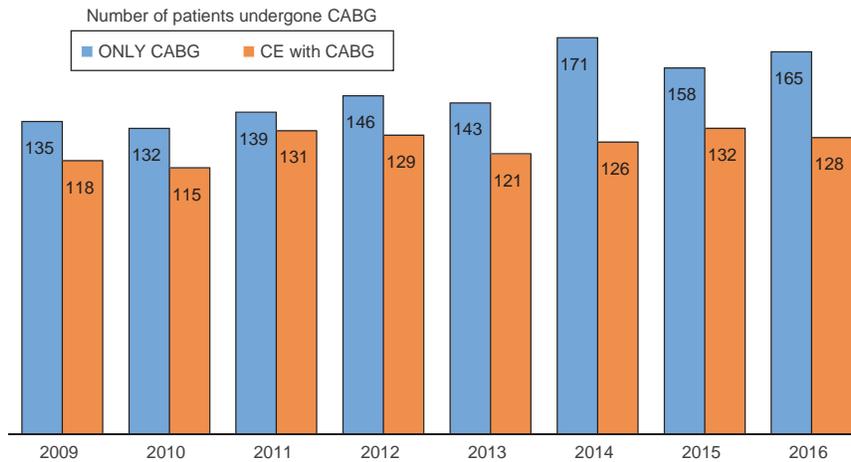


Fig.-3: Bar diagram showing number of patients undergone CABG surgery at different years.

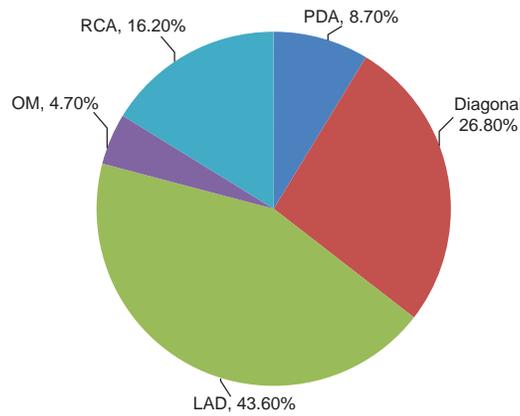


Fig.-4: Pie chart represents territory of endarterectomies in percentage.

Table-I

Pre-operative characteristics of study population.

Variable	Only CABGn=1189	CE with CABGn=1000
Age in years	59.75±2.5	62.5±3.5
Sex		
Male	892 (75.02%)	780 (78%)
Female	297 (24.98%)	220 (22%)
Risk factors		
Hypertension	967 (81.33%)	820 (82%)
Dyslipidemia	938 (78.89%)	768 (76.8%)
Smoking	875 (73.59%)	720 (72%)
Diabetes mellitus	405 (34.06%)	350 (35%)
Family history	675 (56.77%)	550 (55%)
Previous MI	875 (73.59%)	720 (72%)
Angioplasty	158 (13.29%)	150 (15%)
LVEF		
EF >50%	765 (64.34%)	550 (55%)
EF 30-50%	347 (29.18%)	322 (32.2%)
EF <30%	77 (6.48%)	128 (12.5%)
NYHA functional class		
1 - 2	405 (34.06%)	325 (32.5%)
3 - 4	784 (65.94%)	675 (67.5%)
CCS Class		
1 - 2	431 (36.25%)	333 (33.3%)
3 - 4	758 (63.75%)	667 (66.7%)
EuroSCORE	5.6±1.2	5.8±1.6

**Table-II**  
*Per-operative data of study population*

Variable	Only CABG; n=1189	CE with CABG; n=1000	
Number of graft	X <sub>2</sub>	212	110
	X <sub>3</sub>	773	540
	X <sub>4</sub>	172	310
	X <sub>5</sub>	32	40
Internal mammary artery (IMA) use	LIMA	1175 (98.82%)	1000 (100%)
	RIMA	387 (32.55%)	430 (43%)
CPB	On Pump	33 (2.78%)	185 (18.5%)
	Off Pump	1156 (97.22%)	815 (81.5%)
LM Disease	128 (10.77%)	115 (11.5%)	
Operative criteria	Emergency	28 (2.36%)	11 (1.1%)
	Urgent	196(16.48%)	184 (18.4%)
	Elective	965 (81.16%)	805 (80.5%)
Number of Endarterectomy in CE with CABG group; N=1200			
Territory of Endarterectomy	LAD	43.60% (436)	
	OM	4.7% (47)	
	Diagonal	26.8% (268)	
	RCA	16.2 (162)	
	PDA	8.7% (87)	

**Table-III**  
*Post-operative variables of study population*

Variables	Only CABG n=1189	CE with CABG n=1000
Ventilation time (hours)	9.2±1.8	9.5±2.5
ICU stay (hours)	36.2±5.1	36.5±7.1
ICU mortality	20 (1.68%)	18 (1.8%)
Hospital stay (days)	10±1	10±2
Late mortality (>6 months)	3 (0.25%)	9 (0.9%)
New onset AF	125 (10.51%)	150 (15%)
Post-operative Acute MI	17 (1.43%)	33 (3.3%)
Renal failure	26 (2.19%)	25 (2.5%)
Respiratory failure	14 (1.18%)	12 (1.2%)
Neurological complications	9 (0.76%)	15 (1.5%)
Use of IABP(Intra-aortic balloon pump)	6 (0.51%)	8 (0.8%)
Post-operative blood transfusion (units)	1.25±0.5	1.5±0.5
Back to theater	5 (0.42%)	8 (0.8%)

impediment of a little left marginal branch. The major postoperative morbidity and mortality were compared between two group. There was no significant difference in term of postoperative outcome like MI, renal failure, respiratory failure, neurological complication and use of Post-operative IABP.

**Discussion:**

The study evaluated outcomes of CABG with or without CE (coronary endarterectomy) and shown that the complete revascularization of coronary artery disease enhanced the early and late post-operative outcomes following CABG. The mean age of study population was 59.75±2.5 and 62.5±3.5

in only CABG group and CE with CABG group respectively. In this review, 16.5% of the patients required multiple endarterectomies in CE with CABG group (1.2 endarterectomies per patient). The mean graft number were  $3.02 \pm 0.15$  and  $3.28 \pm 0.25$  in only CABG group and CE with CABG group respectively. There were 18.5% conversions to on-pump CABG using cardiopulmonary bypass in CE with CABG Group and Post-operative ICU mortality rate was 1.68% in Group -1, and 1.8% in Group -2. There were no intra-operative mortalities in this study. The mean follow-up period was  $8.5 \pm 3.5$  months (between of 6 to 24 months). In our study, more blood was transfused postoperatively in CE with CABG group rather than only CABG group. At median follow-up of 2.5 years, 91.78% and 88.5% of patients were angina free in Only CABG group and CE with CABG group respectively.

In spite of the presentation of coronary endarterectomy (CE) 40 years prior<sup>1</sup> as a strategy for treatment of diffuse coronary artery disease, its application remains controversial as it conveys a higher perioperative hazard and poor long-term survival. Coronary endarterectomy is performed through a little incision usually 8-10mm arteriotomy, and simpler to reconstruction. Usually we utilize the "Traction technique-slow, sustain and continuous traction" to perform endarterectomy<sup>2</sup>. The potential dangers are inadequate expulsion of the plaque and the "snowplow effect," to be specific, shearing-off of the plaque in the side branches<sup>2</sup>. But with the "open procedure" the vision is better, and that may prompt more entire expulsion of the atheroma from the coronary vessel and its side branches. However, open technique is time consuming and required patch repair. So that, we preferred "traction technique" with careful examination of the atheromatous plaque after expulsion, which also supported by other article<sup>2,16</sup>. Myocardial contraction in the LAD territory is more vigorous than the RCA region. This helps in the extraction of the distal atheromatous plaque by traction technique easily from LAD artery as compared to the RCA<sup>2,16,21</sup>. We also observed that it is easier to remove atheroma from LAD than RCA, which is also described in another article. In a study, Ranjan et al. described about a 14cm long coronary atheroma extracted from right coronary artery during off-pump CABG and postoperative CT angiogram reveals patent RSVG to PDA graft<sup>2</sup>.

There are very few published articles describing combined CE with OPCABG surgery. Now-a-days off-pump CABG surgery for multi vessel myocardial revascularization in high risk patients has been appeared to decrease the frequency of perioperative morbidity and mortality and the duration of hospital stay<sup>7,9</sup>. In a study, Smith et al. observed that majority

of patients are belongs to 61 to 70-year age group, which is similar to our study<sup>8</sup>. Islamoglu et al. shows that total myocardial revascularization improves LV function postoperatively<sup>10</sup>. The low occurrence of readmission to the intensive care unit (ICU), come back to theater for bleeding or cardiac tamponade, infection, and stroke in these high-risk patients in our OPCABG series with concurrent CE contrasts positively with published OPCABG articles<sup>11</sup>. Inadequate myocardial revascularization has been appeared to be a standout amongst the most critical components that influences perioperative outcome, ventricular function, early and late mortality<sup>12,13</sup>. Complete revascularization of the LAD is considered as a crucial determinant of the post-operative patient's recovery<sup>12,13</sup>. Despite the fact that, in our review the commonest site of CE was the LCA territory (75.1%), and LAD endarterectomy was required to be performed in 43.6% of these patients. Curiously, RCA territory (RCA and PDA) endarterectomy was performed in just 24.9% of the entire study population. But majority of the patients have triple vessel disease, which is not similar to other findings<sup>8,12,13</sup>. The endarterectomy procedure is as yet a matter of controversy<sup>14,15</sup>.

Following coronary endarterectomy, routine Heparin infusion was prescribed to prevent thrombosis in graft or native tissue in the early post-operative period followed by oral Warfarin for next 6 months, which is also supported by other articles<sup>2,3,13,14</sup>. Our protocol is that, once postoperative blood draining is settle down (usually 3-4 hours following surgery), we started Heparin usually for 48 hours, followed by bridging to Warfarin (5mg) orally from 1<sup>st</sup> post-operative day. From 3<sup>rd</sup> Post-operative day, we prescribed Warfarin (2.5mg) for next 6 months and dose adjusted according to INR findings (our targeted is INR 1.5-2.5). We also prescribed Clopidogrel and Aspirin (75mg) for life long following CE with OPCABG, which also described in other articles<sup>2,3,13,14</sup>. In our review, only 0.76% and 1.5% patients had transient ischemic attack (TIA) in only CABG group and CE with CABG group respectively with complete recovery, which agrees in the review of Naseri et al. who revealed no neurologic deficit<sup>18</sup>. In a study, Djallilian et al. shows only 9% of their patients got angina at  $46 \pm 19$  months follow up, though Gill et al. observed intermittent angina in 15% of their patients at a mean follow-up of  $36 \pm 16$  months<sup>14,16</sup>. However, the rate of repetitive angina in our study was 11.3% that is equivalent to that announced by different authors after CE with OPCABG. Vohra et al. observed 10% recurrence of angina following OPCABG with coronary endarterectomy which is similar to our study<sup>21</sup>. However, Christakis et al. observed 35% recurrence rate of angina at 5 years follow up in their study, which is significantly higher than our study<sup>22</sup>. This distinction in recurrence of side effects might be because of the

especially extreme nature of the coronary disease or to inadequate revascularization accomplished. One of the confinements of our review is the absence of follow-up angiographic evaluation. However, it is encouraging that 88.7% of our study population were free from angina at long term follow up, which is also supported by others study finding<sup>21</sup>. Naseri et al. revealed a higher postoperative MI rate of 6.8% after OPCABG with CE in completely blocked or more than >50% stenosis<sup>18</sup>. However, multiple published literature shows that acute myocardial infarction (MI) due to acute graft occlusion is a noteworthy complication following CE with an incidence rate of 1.5% to 19%<sup>14,19</sup>. The occurrence of post-operative MI in our study was 1.43% in only CABG group and 3.3% in CE with CABG group. But in another study, Vohra et al. observed that postoperative MI rate following OPCABG with coronary endarterectomy is 4.3%, which is similar to our study<sup>21</sup>.

In our study, the mortality in the both group was associated with aging process, specially age more than 70 years, emergency or urgent CABG surgery, preoperative renal function impairment, multiple comorbidities like diabetes mellitus, peripheral vascular disease, and LV dysfunction. We observed, early mortality is accounted to be higher after LAD endarterectomy and in patients experiencing endarterectomy of more than one coronary artery, which is supported by other authors<sup>7,15</sup>. In a study following CE with OPCABG, Erylimaz et al. shows no mortality at one-year follow-up<sup>19</sup>. Naseri et al. who compared both on pump and off pump CABG with CE, described a mortality of 2.2% in a series of 44 patients<sup>18</sup>. The number of multiple endarterectomies in our review was 16.5%, which is higher in compared to other study<sup>21</sup>. Though Vohra et al. observed 1-year survival rate is 91.5%, and 5-year survival rate is 87.9% are amazing as compared to others study result<sup>21</sup>. Many authors describe the incidence of early mortality after CE with OPCABG is 2-15%<sup>20,22</sup>. But interestingly with regards to CE with OPCABG, Careaga et al. revealed a 30-day mortality of 0% in their small series study<sup>23</sup>. We observed in this study that, endarterectomy of the circumflex artery is unnecessary when vessel is small, in presence of diffuse disease and severe calcification of vessel. Vohra et al. also recommended same as like as our findings following their study<sup>21</sup>.

Beretta et al. observed in their study that, the utilization of the IMA for reproduction of the LAD graft prompts early patency, decreased perioperative myocardial dead tissue, and enhanced 5-year survival rate<sup>17</sup>. However, Mannacio et al. also observed similar findings in their study<sup>24</sup>. Despite the advancement of medical science, the morbidity and mortality following CE with CABG is more prominent than

with CABG alone<sup>26</sup>. However, the consequences of the present review are not concordance with these discoveries<sup>25</sup> as in the both study group patients had a lower mortality in our review. In our review, at 1-year survival rate was 98.07% in only CABG group and 97.3% in CE with CABG group and also 90.08% and 88.7% survival rate at 5 years follow up respectively. Djalilian and Shumway reported higher incidence of mortality in patients who had preoperative myocardial infarction<sup>14,26</sup>. In our review, there was a higher incidence of preoperative MI in patients who required CABG (73.59% in only CABG group and 72% in CE with CABG group), however, CE was not found to be independently associated with mortality in the analysis for the predictors of mortality. Moreover, this mortality was not an aftereffect of the CE, which is also stated by different authors<sup>6,16</sup>. In a study, Brenowitz et al. also reported that multiple endarterectomies are more common in a patients of age over 70 years, diabetes mellitus, female sex, reoperation, and also having severe LV dysfunction<sup>25</sup>. Atik et al. observed in a study that female sex, previous MI, left main disease, diabetes mellitus, and a low ejection fraction (<35%) to be related with higher incidence of early mortality<sup>26</sup>.

#### **Conclusion:**

In diffuse coronary artery disease, CE (Coronary endarterectomy) with off-pump coronary artery bypass graft is attainable and accomplishes total myocardial revascularization; when there are no other alternative options for sufficient revascularization. Surgical skill and the patient's selection criteria are main stream for better outcome in CE with CABG surgery, despite the higher risk group, severe LV dysfunction, and diffuse coronary lesion.

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#### **Disclosure of interests:**

No potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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