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ORIGINAL ARTICLE

Ten Year's Experience with Coronary Endarterectomy in Bangladesh: A Retrospective Study

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Abstract:

Objective: *In this study, we review the consequences of coronary endarterectomy (CE) with coronary artery bypass grafting (CABG), and demonstrate the outcomes of this surgical technique for patients with diffuse coronary artery disease in a single surgeon's practice.*

Methods: *We retrospectively reviewed outcome of 1473 endarterectomized coronary artery in 1189 patients with diffuse coronary artery disease (CAD), who have had experienced CE with OPCABG in the year of 2007 to 2016. CE was performed in multi-segmental diffuse CAD, or when a calcified or extremely thick plaque making anastomosis troublesome.*

Results: *Approximately 75% Coronary endarterectomy were performed in the left coronary territory and most commonly left anterior descending artery was endarterectomized (42.83%). An average of 1.24 coronary endarterectomies performed per patient. Post-operative ICU and 30-days mortality rate was 2.19%, and 0.59% respectively in CE group. Post-operative atrial fibrillation, acute MI, neurological complication and also blood transfusion was significantly higher in CE group. Following CE, five year's survival rate was 89.48% and 84.77% were free from angina at follow-up of 5 years.*

Conclusion: *Coronary endarterectomy with OPCABG is attainable and accomplishes surgical revascularization in patients; when there is no other alternative for total myocardial revascularization.*

Key words: *Coronary endarterectomy, Coronary artery disease, Coronary artery bypass graft.*

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Introduction:

Ischemic heart disease (IHD) patients, who are referred for coronary artery bypass graft (CABG) surgery are progressively getting more complex with multiple comorbidities, and subsequently, this group of patients have diffuse coronary artery disease, which has made complete surgical revascularization more difficult. In the late 1957, Coronary endarterectomy was at first presented as a surgical option for myocardial revascularization by Bailey et al.[1]

Coronary Endarterectomy (CE) is the expulsion of the atheromatous plaque, and isolating the outer media and adventitia layers of arterial wall. CE is frequently important to perform total myocardial revascularization during CABG or to encourage anastomosis of severely calcified and diffuse coronary arteries[1,2]. Inadequate myocardial revascularization does not influence the early death rate, but rather the occurrence of restenosis which influences the long term cardiac dysfunction. These patients have more prominent repeated attacks of angina, and

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more noteworthy work absence rate and require a higher number of re-interventions following CABG[3,4].

This study went for assessing the consequences of coronary endarterectomy (CE) in a single surgeon's practice and to provide details regarding treatment strategies for patients having diffuse coronary artery disease.

Patients and Methods:

Between the years 2007 to 2016, total 2647 number of patients were submitted to CABG procedure with or without CE in a single surgeon's practice. CE was considered for distal diffuse lesion, multi-segmental lesion; or when a calcified or extremely thick plaque burst, making anastomosis troublesome or hindering the distal stream. During this study, every patient was reached either during outpatient department visit (OPD) or by phone call and data was noted to data sheet. Pre-operative variables of study population are shown in Table-1.

Surgical Technique: All procedures were performed through a standard median sternotomy and a CPB circuit was kept on standby for all cases. Heparin was used just before completing LIMA harvest 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). We utilized mechanical stabilizers like suction type and the compression type; to immobilize the target coronary artery during grafting.

A conclusive decision to endarterectomize a vessel is made per-operatively. Coronary endarterectomies were performed manually by utilizing the closed methods- "slow sustain and continuous traction" of atheromatous plaque with the aid of delicate Ring Forceps, followed by reproduction with anastomosis with pre-planned graft. The arteriotomy incision was roughly 8-10mm long, however that was stretched out for another 5mm in few cases. Much consideration was provided to the entire expulsion of the distal segment, but complete proximal endarterectomy avoided due to the danger of competitive flow loss between the graft and the native artery. To ensure complete expulsion, the atheromatous plaque carefully inspected for a smooth distal tapper end. 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. In this study, longest atheroma (14cm in size) was removed from RCA and also another 10cm atheromatous plaque extracted from LAD during OPCABG (Figure-1). In early post-operative period, every patient received Heparin infusion bridging to Warfarin from the first post-operative day for next 3-6 months. In this study, a combination of Clopidogrel with Aspirin (75 mg) also used to anticipate acute thrombosis at the graft and also in the endarterectomies artery. Usually Warfarin started with 10mg daily for first 3 post-operative days followed by 2.5-5mg for next 3 to 6 months and dose was adjusted according to INR level (Targeted INR was 1.5-2.5).

We assessed the outcome of study population by survival rate, post-operative cardiovascular and neurological event, NYHA functional class, TEE (Transthoracic Echocardiography) and also CT angiogram used to demonstrate cardiac function and graft patency rate (Figure-2).

Result:

A total of 2647 patients were undergone surgical revascularization in this review. However, 1189 patients underwent CE with CABG (Group-1), and 1458 patients underwent only CABG (Group-2) surgery. Total 1473 coronary endarterectomies were performed in Group-1, that is an average of 1.24 coronary endarterectomies performed per patient. Approximately two-third CE were performed in the left coronary territory and in 42.83% cases LAD (left anterior descending artery) required endarterectomies and grafted with LIMA (Left internal mammary artery). Used conduit for LAD graft was LIMA in 100% cases for CE with CABG group, and 99.25% in only CABG group. Mean number of graft were 3.21±0.25 in CE with CABG group, and 3.02±0.15 in only CABG group. There were 13.29% conversions to on-pump CABG using cardiopulmonary bypass in CE with CABG Group but only 3.84% conversions in only CABG Group. Operative data of study population are shown in Table-2.

There were no intra-operative mortalities in this study, however post-operative ICU mortality rate was 2.19% in Group -1, and 1.44% in Group -2. A mean of 1.75±0.5 units of blood was

transfused postoperatively in CE with CABG group, which is more than only CABG group (P value <0.05). The major postoperative morbidity and mortality were compared and there was no significant difference between two group. At 5 years follow up, about 89.10% and 87.34% patients were in regular follow-up in CE with CABG, and only CABG group respectively. However, approximately 85% and 87% patients were free from angina (NYHA Class 1-2) in group-1 and Group-2 respectively. With TTE evaluation, approximately 65% patient have good LV function (EF>50%) in both group, which is statistically significant (P value <0.05) compared to preoperative LVFE. However, mortality rate was more common among poor LV function (EF<30%) group of patients. Postoperative CT angiogram was not available for all study population due to lack of financial support, although 135 CT angiogram were performed and graft patency rate was 90.8% in Group-1 and 91.2% in Group-2 at 5 years follow up. The rest of the postoperative outcome variables are listed in Table- 3 and Table-4.

Table-I

Pre-operative characteristics of study population

	Variable	CE with CABG (n =1189)	Only CABG (n=1458)
Age (mean) in years	61.25±5.5	59.75±2.5	
Sex	Male	935 (78.64%)	1094 (75.03%)
	Female	218 (21.36%)	364 (24.97%)
Risk factors	Hypertension	983 (82.67%)	1186 (81.34%)
	Dyslipidemia	916 (77.03%)	1147 (78.67%)
	Smoking	837 (70.40%)	1068 (73.25%)
	Diabetes Mellitus Type-1	423 (35.58%)	497 (34.09%)
	Type-2	766 (64.42%)	961 (65.91%)
	Family history of IHD	672 (56.52%)	795 (54.53%)
Previous Myocardial Ischemia		854 (71.83%)	1073 (73.59%)
Angioplasty	Left Anterior Descending	106 (8.92%)	167 (11.45%)
	Right Coronary Artery	67 (5.63%)	97 (6.65%)
LV Ejection Fraction	EF >50%	703 (59.13%)	907 (62.21%)
	EF 30-50%	359 (30.20%)	428 (29.36%)
	EF <30%	127 (10.67%)	123 (8.43%)
NYHA class	1 - 2	406 (34.15%)	538 (36.90%)
	3 - 4	783 (65.85%)	920 (63.10%)
CCS Class	1 - 2	395 (33.22%)	529 (36.28%)
	3 - 4	794 (66.78%)	929 (63.72%)
EuroSCORE	5.9±1.8	5.7±1.5	

Note: IHD- Ischemic Heart Disease, NYHA- New York Heart Association, CCS- Canadian Cardiovascular Society, EuroSCORE- European System for Cardiac Operative Risk Evaluation.

Table-II

Operative data of study population

Data		CE with CABG (n=1189)	Only CABG (n=1458)
Number of graft	X_2	162 (13.62%)	259 (17.76%)
	X_3	661 (55.60%)	951 (65.23%)
	X_4	324 (27.25%)	209 (14.34%)
	X_5	42 (3.53%)	39 (2.67%)
Use of Internal mammary artery (IMA)	Left IMA	1189 (100%)	1447 (99.25%)
	Right IMA	492 (41.38%)	462 (31.68%)
Use of Cardiopulmonary Bypass	YES	158 (13.29%)	56 (3.84%)
	NO	1031 (86.71%)	1402 (96.16%)
LM Disease	152 (12.78%)	173 (11.87%)	
Operative criteria	Emergency	16 (1.35%)	39 (2.67%)
	Urgent	201 (16.90%)	241 (16.53%)
	Elective	972 (81.75%)	1178 (80.80%)
Number of Endarterectomy in CE with CABG group			
Territory of endarterectomy (N=1473)	LAD	631 (42.83%)	
	OM	52 (3.53%)	
	Diagonal	298 (20.23%)	
	RCA	242 (16.43%)	
	PDA	119 (8.08%)	
	LAD + RCA	81 (5.50%)	
	LAD + Diagonal	27 (1.83%)	
	RCA + Diagonal	23 (1.57%)	

Note: LAD- Left Anterior Descending, OM-Obtuse Marginal, RCA- Right Coronary Artery, PDA- Posterior Descending Artery.

Table-III

Early post-operative variables of study population

Variables	CE with CABG (n=1189)	Only CABG (n=1458)	P-value
Ventilation time (hours)	9.9±1.25	9.3±1.8	<0.001
ICU stay (hours)	36.8±6.7	36.1±5.1	0.002
ICU mortality	26 (2.19%)	21 (1.44%)	0.148
30 days mortality	7 (0.59%)	0 (0%)	0.004
Hospital stay (days)	10±1.5	10±1	1.00
Post-operative AF	187 (15.73%)	152 (10.43%)	<0.001
Post-operative Acute MI	42 (3.53%)	19 (1.30%)	<0.001
Renal failure	27 (2.27%)	29 (1.99%)	0.715
Respiratory failure	16 (1.35%)	17 (1.17%)	0.811
Neurological complications TIA	8 (0.67%)	0 (0%)	0.002
Psychosis	13 (1.10%)	12 (0.82%)	0.608
Use of IABP	15 (1.26%)	7 (0.50%)	0.047
Post-operative blood transfusion (units)	1.75±0.5	1.25±0.5	<0.001
Postoperative hemorrhagic complication	12 (1.01%)	6 (0.41%)	0.104

P value are reached from chi square test and P<0.05 are statistically significant.

Note: ICU- Intensive Care Unit, AF- Atrial Fibrillation, MI- Myocardial Infarction, TIA- Transient Ischemic Attack, IABP- Intra-Aortic Balloon Pump.

Table-IV

Long term outcome variables of study population

Variables		Outcome at 5 years Follow up		P value
		CE with CABG	Only CABG	
Survival rate at 5 years	1064 (89.48%)	1327 (91.02%)	0.209	
Follow Up schedule	Regular	948 (89.10%)	1159 (87.34%)	0.209
	Irregular	116 (10.90)	168 (12.66%)	
NYHA Functional Class	1-2	902 (84.77%)	1147 (86.44%)	0.274
	3-4	162 (15.23%)	180 (13.56%)	
Follow up evaluation with Transthoracic Echocardiogram (TTE)				
Number of Patient	(N=865)	(N= 1043)	<0.001	
LV Ejection Fraction (EF)	EF >50%	554 (64.05%)	687 (65.87%)	
	EF 30-50%	274 (31.68%)	342 (32.79)%	
	EF <30%	37 (4.27%)	14 (1.34%)	
Follow up evaluation with CT angiogram				
Number of Patient (N=135)	(N=60)	(N=75)	0.634	
Number of graft (n=410)	n=182 Graft	n= 228 Graft		
Graft patency rate	Patent	90.70%	91.23%	
	Stenosis	6.59%	6.57%	
	Occluded	2.71%	2.20%	

P value are reached from chi square test and P<0.05 are statistically significant.
Note: NYHA- New York Heart Association, LV- Left Ventricle.

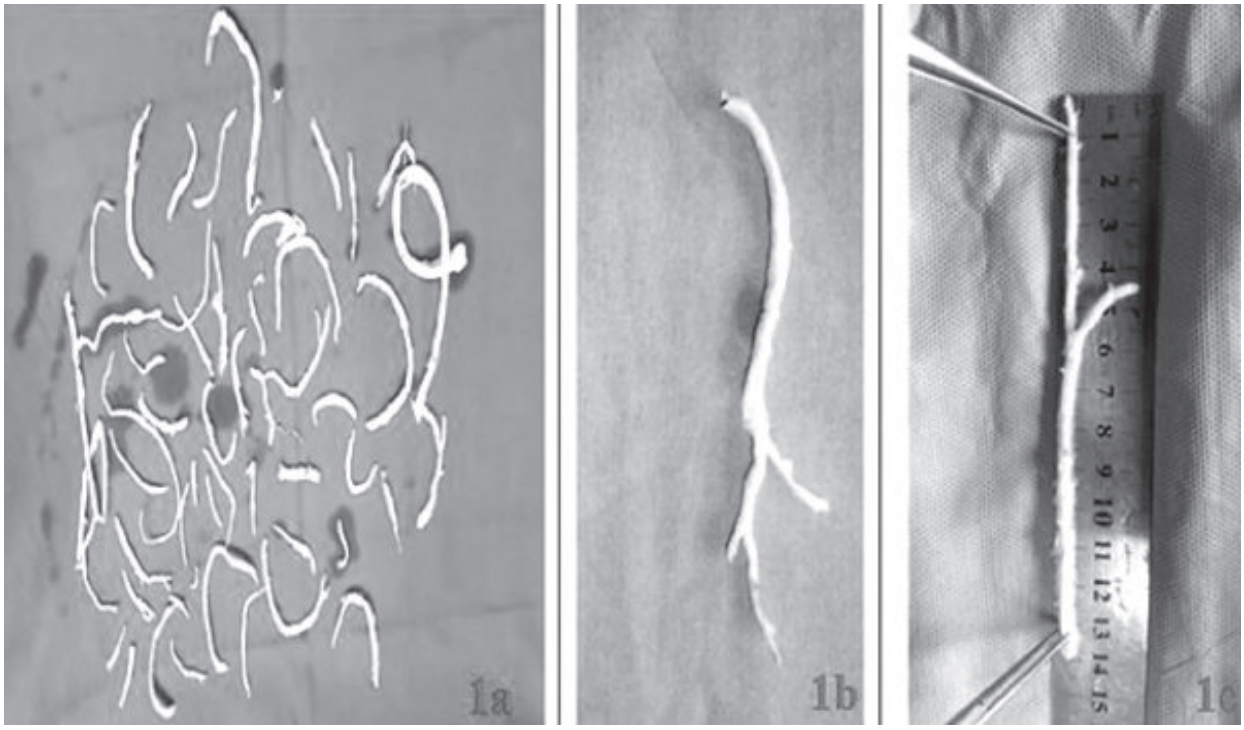

Figure-1: Photograph illustrate coronary atheroma. (1a) Bunch of Coronary atheroma; (1b) Tapper end of atheroma indicates complete endarterectomy; (1c) Longest atheroma (14 cm) extracted from Right Coronary Artery.

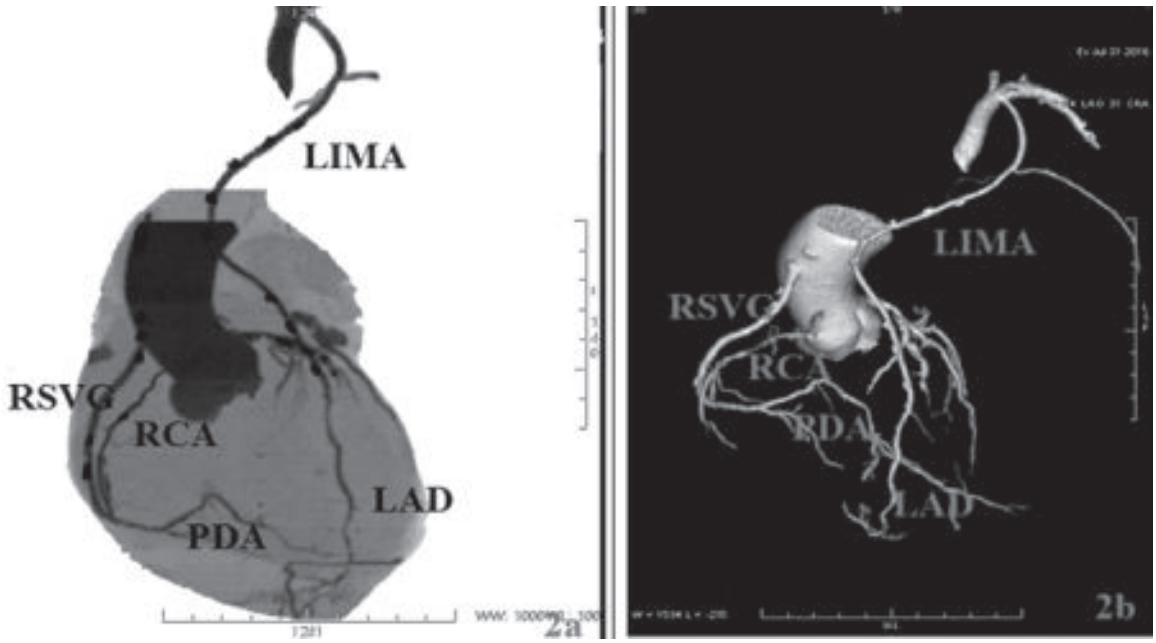

Figure-2: Postoperative CT Angiogram following CE with CABG (2a) and (2b); Patent distal anastomosis graft-LIMA to LAD; RSVG to PDA graft; (A 14cm long atheroma was extracted from RCA of this patient).

Discussion:

In this study, we evaluated the outcomes of coronary endarterectomy in CABG surgery having diffuse coronary artery disease (CAD) and shown that the complete revascularization of diffuse CAD enhanced the early and late post-operative outcomes following CABG. The mean age of study population was 61.25 ± 5.5 and 59.75 ± 2.5 in endarterectomy and only CABG group respectively. In this study, 1.24 endarterectomies required per patient in CE group. Out of total endarterectomies, two third endarterectomy was done in Left coronary territory, and mean graft number were 3.21±0.25 and 3.02±0.15 in CE Group and only CABG Group respectively. There were only 13.29% and 3.84% cases required cardiopulmonary bypass support in two groups respectively. Post-operative ICU mortality and 30 day's mortality rate was minimum in both study group, and all of the patients were belongs to poor LV function (EF<30%) group. In this study, a mean of more blood was transfused post-operatively in CABG with endarterectomy group (P value <0.05). At median follow-up of 5 years, most of the patients were angina free in both group, however, the incidence of post-operative MI and atrial fibrillation rate was higher in endarterectomy group (P value <0.05).

In spite of the presentation of coronary endarterectomy (CE) 60 year's prior as a strategy for treatment of diffuse coronary artery disease, its application remains controversial due to higher perioperative hazard and poor long term survival rate[1,2-6]. But complete myocardial revascularization for multi vessel CAD patients has been appeared to reduce the frequency of perioperative morbidity and mortality and the duration of hospital stay[7-11]. In a study, Jones et al. observed that complete myocardial revascularization appeared to be a most critical component influencing perioperative outcome, ventricular function, early and late post-operative morbidity and mortality[12]. Though LAD endarterectomy is higher hazardous, however complete revascularization of the LAD is considered as a crucial determinant of the post-operative patient's recovery[8, 10-13]. In this study, approximately 75% of the coronary endarterectomy was performed in the left coronary territory and outcome was satisfactory.

In a review, Eryilmaz et al. described that coronary endarterectomy yet a matter of

controversy[14], which also supported by other article[13-15]. Closed technique for CE procedure is more straightforward, and easy to performed through small incision, and easy to reconstruction. But the potential dangers are inadequate expulsion of the plaque and the "snowplow effect," means shearing-off of the plaque in the side branches. However, with the open technique CE, the vision is better, and that may prompt more entire expulsion of the atheroma from coronary artery and also from side branches[10-15]. But closed traction technique for CE was preferred because of open strategy is time consuming, required patch repair, and also myocardial contraction helps extraction of atheroma during off-pump beating heart CABG which also supported by other articles[15,16]. Though Adhikary et al. observed 9.9% neurological complications following open heart surgery[16], but only 1.8% patient had neurological complications with complete recovery in our study, which agrees the findings of other studies also[10-15, 17].

In a study, Gill et al. demonstrate satisfactory early and late clinical results with luminal patency of IMA to an endarterectomized vessel compared to great saphenous vein conduit[17]. However, in a study Naseri et al. demonstrate higher incidence of completely blocked or significant stenosis in graft and endarterectomized artery on CT angiogram and a higher incidence of (6.8%) postoperative MI rate[18]. Though in our study, post-operative MI occurrence was only 3.53% and follow up CT angiogram revealed 64.44% graft patency rate at 5 year's follow-up, which is similar to other study also[10,17,19-21]. Moreover, in this study ICU and 30-days mortality rate was 2.19% and 0.59% respectively, and this mortality were more common among certain group of patients like after LAD endarterectomy, multi-vessel CE, and preoperative poor LV function (EF<30%), though Careaga et al. revealed a 30-day mortality of zero percent in their small series of study[22]. But many authors described the average frequency of early mortality after CE with OPCABG of 2-15%[15-18, 20,21].

Following coronary endarterectomy, routine Heparin infusion was prescribed to prevent thrombosis in graft or native endarterectomized artery, bridging to oral Warfarin for next 3 to 6 months, which is also supported by other articles[2,10-15, 19-22]. In this study, Heparin was used (usually 5000IU subcutaneously 8 hourly) in the early post-operative period, usually 3-4 hours following surgery, followed by oral Warfarin (5-10mg) till 3rd post-operative day. From 4th Post-operative day to onwards, Warfarin was used at a dose of 2.5 to5mg for next 3 to 6 months and dose was adjusted according to INR (targeted was INR 1.5-2.5). This study also prescribed combination of Clopidogrel and Aspirin (75mg) for life long from 1st post-operative day, which also supported by other authors[6,10-16,21-23].

In this study we observed that, only CABG surgery is not sufficient to provide total revascularization in presence of complex CAD with diffuse lesion, stent restenosis, and LV dysfunction, where need to do concurrent coronary endarterectomy in addition to CABG to achieved good distal run-off and better postoperative outcome. However, surgical skills and postoperative anticoagulation therapy remains the key stream in our study and CE was not found to be independently associated with mortality in the analysis for the predictors of mortality.

Conclusion:

Coronary endarterectomy is feasible and a good surgical options for total myocardial revascularization in patients with diffuse coronary artery disease and should not be considered as a contraindication to OPCABG. However, surgical skill, patient's selection criteria, and postoperative anticoagulation therapy are the key words for better outcome following CE with CABG.

DISCLOSURE OF INTERESTS:

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

CONTRIBUTION TO AUTHORSHIP:

Ranjan R[1] - Conception, planning, Data collection, carrying out, analyzing and writing up of the work.

Adhikary AB[2] - Provide active help, guidance and valuable suggestions regarding analysis and writing up the work.

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