Disease Patterns and Outlook with Coronary Artery Bypass Grafting

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Abstract

Background: Outcomes of Coronary Artery Bypass Grafting (CABG) are often measured by mortality and morbidity rates. This study aims to analyze disease patterns, graft types, surgical techniques, and post-operative outcomes of CABG, comparing pre-operative findings, past history, and major morbidity and mortality as defined by the Society of Thoracic Surgeons (STS)), USA.

Methods: A retrospective comparative study was conducted with 390 patients, who were underwent CABG. The data were collected from January 2017 to December 2020 where CABG of these patients done within January 2014 to December 2016.

Results: Demographics & Risk Factors: 89.7% were male. No significant differences in BMI or other risk factors distribution (hypertension most common, followed by diabetes, smoking, and hyperlipidemia) (P>0.05). Cardiac Function & Disease Severity: LVEF%: Group A: 51.18 ± 8.76%, Group B: 51.85 ± 8.73% (P>0.05). Triple vessel disease: Group A: 81.5%, Group B: 83.6% (P>0.05). Grafting & Surgery: No significant difference in conduit types or graft use (LAD grafts: Group A: 99%, Group B: 99.5%) (P>0.05). Off-pump surgery was more common (49.49% in Group A, 48.46% in Group B). Postoperative Complications: AKI (Group A: 7.7%, Group B: 16.9%, significant), LOS (Group A: 0.5%, Group B: 4.1%, significant), mortality (Group A: 37.5%, Group B: 62.5%, P>0.05). Surgical Outcome Comparison: Off-pump surgery: mortality 3.4% (13/382), on-pump beating heart surgery: mortality 37.5% (3/8) (P=0.003, significant). Mortality Correlation: Multi-organ failure (strongest predictor), COPD & stroke (moderate), AKI, LOS, EF, old MI, syncope (weak), hyperlipidemia & renal dysfunction (weak). LV dysfunction had a significant negative impact.

Conclusion: Syncope and certain major morbidities differed between the groups, but overall mortality rates were similar. The study highlights specific pre-operative and post-operative factors affecting CABG outcomes.

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Introduction

Coronary artery disease (CAD) is an important medical and public health issue because it is a common and leading cause of death throughout the world. Bangladesh has been experiencing epidemiological transition from communicable disease to non-communicable disease (NCD). The overall mortality due to chronic diseases, especially the 'fatal four' i.e. cardiovascular disease, cancer, chronic respiratory disease and diabetes, are increasing in an alarming rate.[1]

Incidence of CAD is on the rise in the developing countries including Bangladesh. In 2001 the incidence of ischemic heart disease in Bangladesh was reported to be 3.4% and it is definitely rising very alarmingly. Ischemic Heart Disease was reported as the third most prevalent disease in Bangladesh.[2] Bangladesh Demographics Profile 2016 said that in Bangladesh total population is 156,186,882 among those most percentage of populations of age group 25-54 years which is 39.39 % of the total population.[3]

First Coronary care started in this country in BSMMU in 1978, First integrated cardiovascular care started in this country with the formal establishment of National Institute of Cardiovascular Diseases (NICVD) in 3rd April 1981.[4] In this institute for the first time, percutaneous transluminal coronary angioplasty (PTCA) was done by foreign experts in 1987 and by Bangladeshi team in 1995 & coronary stenting in 1997.[5] First Coronary Artery Bypass Grafting (CABG) was done in NICVD in 1985. Since then, cardio-vascular care facilities have increased steadily, and at present good number of institutions in public, as well as, in private sector are rendering cardiovascular care throughout the country, though they are more concentrated in the capital city.[6]

Coronary Artery Bypass Grafting (CABG) was first introduced in 1967 and evolved rapidly as the standard of care for patients with extensive coronary artery disease.[7] However, the introduction of percutaneous coronary intervention (PCI) lead to a reconsideration of therapeutic strategies.[8] Despite converging outcomes between the two treatments in selected patients, coronary surgery currently remains the standard of care for most elective patients, including those with diabetes and or complex left main or three-vessel disease.[9]Although short-term outcomes have dramatically improved overthe first 50 years, surprisingly, technical aspects of the CABG procedure did not change significantly. Particularly in an era of increasing and sometimes overuse of PCI, several aspects of CABG should be improved to further optimize short- and long-term outcomes,while at the same time improving the appeal of CABG which is regarded as an overly invasive attractive treatment. CABG is performed where more than one vessel involved such as in DVD or TVD or in SVD where left main coronary artery was involved.[10]

There is no such study on pre-operative disease pattern and details about the grafts which are used and immediate post-operative outcome of coronary artery bypass grafting for young adult. There are several risk factors which is associated with coronary heart disease such as Hypertension, Diabetes Mellitus, Smoking and smokeless tobacco use, Dyslipidemia and Lifestyle related factors. As a result of socioeconomic transition, lifestyle, the dietary pattern has been changing in Bangladesh. Increasing prevalence of obesity, tobacco use, high intake of processed foods and less physical activity accompany the transition.

Methods

This was a retrospective comparative study where data has been collected from the department of cardiac surgery, National Heart Foundation Hospital & Research Institute, Mirpur, Dhaka from January 2017 to December 2020. Patients only coronary artery bypass grafting both on-pump & off-pump from the period of January 2014 to December 2016 were enrolled. Sample was selected randomly. The following formula was used for calculating sample size:

The formula is

ni = {p_1 (1 –p1)+p_2 (1-p_2)} (Z/E)^2

ni = 1 & 2; 1 = Group A, 2 = Group B

Z = 1.96, at 95% confidence level

p1= 0.5

p2= 0.5

Z= 1.96 in 95% confidence level

E = 10% margin of error = 0.1

So, ni = {0.5(1-0.5) + 0.5(1-0.5)} (1.96 / 0.1)2

= (0.25 + 0.25) (19.6)2

= 0.5 X 384

=192

So required sample size for ni = n1= Group A=192 and required sample size for ni = n2 = Group B =192, leading to total sample size for this study was 384.

Data were divided into two groups: Group A: 35 to 50 years of age patient and Group B: 51 to 65 years of age patient. A structured questionnaire was prepared in English for data collection with the consideration of all variables of the study. Data was entered in Statistical Package for Social Science (SPSS) program version 22 and analyze accordingly. Data were presented in the form of tables. Descriptive statistics were presented with frequency tables. Association was illustrated with cross tables and test of significance. Data Quality management ensures the complementation of all phases, accurate and valid information, consistent styles and quality of the research.

Results

Table I shows, the CABG patients were predominantly male in both groups, with 350 males (89.7%) and 40 females (10.3%), showing no significant difference (P>0.05). In group A, 1 patient (0.5%) had a BMI <18.5 kg/m², while 4 patients (2.1%) in group B had a BMI <18.5 kg/m². In group A, most patients had a BMI >25 kg/m², followed by 18.5-24.99 kg/m² and >30 kg/m². In group B, the highest BMI group was 18.5-24.99 kg/m², followed by >25 kg/m² and >30 kg/m². This BMI distribution difference was not significant (P>0.05).

Table I: Socio-demographic distribution of the respondents

Variables	Group A (Age: 35 to 50 years) (n=195) f(%)	Group B (Age: 51 to 65 years) (n=195) f (%)	P value
Sex			
Male	173(88.7)	177(90.8)	0.504
Female	22(11.3)	18(9.2)	
BMI			
<18.5	1(0.5)	4(2.1)	0.095
18.5 to 24.99	90(46.2)	109(55.9)	
>25	92(47.2)	74(37.9)	
>30	12(6.2)	8(4.1)	

Table II: Distribution of respondents according to their risk factors

Variables	Group A (Age: 35 to 50 years)		Group B (Age: 51 to 65 years)		P value
	Number	%	Number	%	
Diabetes Mellitus	113	(57.9)	98	(50.3)	0.127^{NS}
Hypertension	124	(63.6)	121	(62.1)	0.753^{NS}
Hyperlipidemia	63	(32.3)	66	(33.8)	0.747^{NS}
Smoking	87	(44.6)	105	(53.8)	0.068^{NS}

NS- not significant

Table II shows, the risk factors were comparably distributed in both the groups. Hypertension was the most predominant risk factor followed by diabetes, smoking and hyperlipidemia in both groups. There was no statistically significant difference regarding the risk factors in between the groups (P>0.05).

Table III: Distribution of respondents according to their clinical findings

Variables	Group A (Age: 35 to 50 years) (n=195) f (%)	Group B (Age: 51 to 65 years) (n=195) f (%)	P value
LVEF (%) Mean + SD	51.18+8.76	51.85+8.73	0.456
NYHA CLASS			
Class 1	13 (6.7)	10 (5.1)	0.866
Class 2	114 (58.5)	110(56.4)	
Class 3	59(30.3)	64(32.8)	
Class 4	9(4.6)	11(5.6)	
LV Dysfunction			
Normal	61(31.3)	72(36.9)	0.635
Mild	58(29.7)	50(25.6)	
Moderate	65(33.3)	64(32.8)	
Severe	11(5.6)	9(4.6)	
Disease Pattern according to angiography			
SDV	7(3.6)	8(4.1)	
DVD	29(14.9)	24(12.3)	
TVD	159(81.5)	163(83.6)s	0.637
Total no. of vessels involved Mean + SD	2.7795 + 0.49491	2.7949 + 0.49635	
Angiographic coronary arteries involvement			
LAD	189 (96.9)	190 (97.4)	0.760^{NS}
LCX	150 (76.9)	152 (77.9)	0.809^{NS}
OM1	41 (21.0)	42 (21.5)	0.902^{NS}
OM2	43 (22.1)	34 (17.4)	0.252^{NS}
RCA	165 (84.6)	163 (83.6)	0.782^{NS}
PDA	21 (10.8)	25 (12.8)	0.530^{NS}
PLV	16 (8.2)	15 (7.7)	0.852^{NS}

Table III shows, LVEF% preoperative: Group A: 51.18 ± 8.76%, Group B: 51.85 ± 8.73% (P>0.05). NYHA class: Group A: II (5.5%), III (30.3%), I (6.7%), IV (4.6%). Group B: II (56.4%), III (32.8%), IV (5.6%), I (5.1%) (P>0.05). Severe LV dysfunction: Group A: 5.6%, Group B: 4.6%. Normal LV: Group A: 31.3%, Group B: 36.9% (P>0.05).Triple vessel disease: Group A: 81.5%,

Group B: 83.6%. Single vessel disease: Group A: 3.6%, Group B: 4.1% (P>0.05). Mean number of vessels: Group A: 2.7795 ± 0.49491, Group B: 2.7949 ± 0.49635 (P>0.05). LAD involvement: Group A: 96.9%, Group B: 97.4%. RCA involvement: Group A: 84.6%, Group B: 83.6%. LCX involvement: Group A: 76.9%, Group B: 77.9%. OM1 involvement: Group A: 21%, Group B: 21.5%. PDA involvement: Group A: 10.8%, Group B: 12.8% (P>0.05).

Table IV: Distribution of respondents according to their past history of diseases

Past history of diseases	Group A (Age: 35 to 50 years) (n=195) f (%)	Group B (Age: 51 to 65 years) (n=195) f (%)	P value
Bronchial Asthma	11 (5.6)	16 (8.2)	$^{b}0.373^{NS}$
COPD	4 (2.1)	11(5.6)	$^{a}0.111^{NS}$
OMI	68 (34.9)	63 (32.3)	$^{b}0.592^{NS}$
Syncope	0 (0.0)	15 (7.7)	$^{a}0.000^{S}$
Renal Dysfunction	9 (4.6)	16 (8.2)	$^{b}0.148^{NS}$

(a-Fisher's Exact test, b- Chi square test, S- significant, NS-not significant)

Table IV shows, in Group A, 0% had syncope, while in Group B, 7.7% did (p>0.05). Group A had a history of myocardial infarction (34.9%), bronchial asthma (5.6%), renal dysfunction (4.6%), and COPD (2.1%), whereas Group B had renal dysfunction and bronchial asthma (8.2% each) and COPD (5.6%).

Table V: Distribution of respondents according to their graft given vessel and types of conduits used

Variables	Group A (Age: 35 to 50 years) (n=195) f (%)[Grafts given in vessels Mean ± SD]	Group B (Age: 51 to 65years) (n=195) f (%) Grafts given in vessels Mean ± SD	P value
Grafts given vessels			
LAD	193 (99)	194 (99.5)	0.562^{NS}
Diagonal	94 (48.2)	114 (58.5)	0.042^{S}
OM 1	162 (83.1)	163 (83.6)	0.892^{NS}
OM 2	62 (31.8)	57 (29.2)	0.582^{NS}
PDA	146 (74.9)	151 (77.4)	0.552^{NS}
RV Branch	32 (16.4)	42 (21.5)	0.197^{NS}
PLV	22 (11.3)	31 (15.9)	0.184^{NS}
Types of conduits used			
Both type grafts	193(99)	194(99.5)	0.624
Only venous grafts	0(0)	1(0.5)	

(NS-not significant)

Table V shows, In Group A, 193 out of 195 patients (99%) received LAD grafts, while in Group B, 194 (99.5%) did. OM1 grafts were used in 83.1% of Group A and 83.6% of Group B; PDA in 74.9% of Group A and 77.4% of Group B; Diagonal in 48.2% of Group A and 58.5% of Group B, with a significant difference (P>0.05). Both LIMA and GSV conduits were used in 99% of Group A and 99.5% of Group B, with no significant difference in conduit types (P>0.05).

Table VI: Distribution of the respondents according to their coronary diameter of given grafts

Coronary Diameter	Group A (Age: 35 to 50 years) (n=195) f (%)				Group B (Age: 51 to 65years) (n=195) f (%)				P value
	1.25	1.50	1.75	2.00	1.25	1.50	1.75	2.00	
LAD	12 (6.2)	133 (68.9)	37 (19.1)	11 (5.6)	12 (6.18)	141 (72.68)	34 (17.52)	7 (3.61)	0.812^{NS}
Diagonal	20 (21.2)	70 (74.47)	4 (4.26)	0 (0)	22 (19.29)	87 (76.32)	5 (4.38)	0 (0)	0.236^{NS}
OM 1	29 (17.90)	125 (77.16)	8 (4.93)	0 (0)	23 (14.11)	130 (79.75)	9 (5.52)	1 (0.61)	0.761^{NS}
OM 2	11 (17.74)	49 (79.03)	2 (3.23)	0 (0)	13 (22.81)	44 (77.19)	0 (0)	0 (0)	0.470^{NS}
PDA	37 (25.34)	64 (43.83)	42 (28.77)	3 (2.05)	38 (25.16)	51 (33.77)	60 (39.73)	0 (0)	0.101^{NS}
RV Branch	11 (34.37)	16 (50.00)	5 (15.62)	0 (0)	15 (35.71)	20 (47.61)	7 (16.66)	0 (0)	0.635^{NS}
PLV	5 (22.72)	15 (68.18)	2 (9.09)	0 (0)	11 (35.48)	18 (58.06)	2 (6.45)	0 (0)	0.430^{NS}

S- significant, NS-not significant

Table VI shows, on coronary artery bypass grafting, graft diameters were measured in groups A and B. Group A:LAD: 1.50mm (68.9%), 1.25 mm (6.2%), 2 mm (5.6%), Diagonal: 1.50 mm (74.47%), 1.25 mm (21.2%), 1.75 mm (4.26%), OM1: 1.50 mm (77.16%), 1.25 mm (17.90%), 1.75 mm (4.93%), OM2: 1.50 mm (79.03%), 1.25 mm (17.74%), 1.75 mm (3.23%), PDA: 1.50 mm (43.83%), 1.25 mm (25.34%), 2 mm (2.05%), RV: 1.50 mm (50%), 1.25 mm (34.37%), 1.75 mm (15.62%), PLV: 1.50 mm (68.18%), 1.25 mm (22.72%), 1.75 mm (9.09%)

Group B: LAD: 1.50 mm (72.68%), 1.25 mm (6.18%), 2 mm (3.61%), Diagonal: 1.50 mm (76.32%), 1.25 mm (19.29%), 1.75 mm (4.38%), OM1: 1.50 mm (79.75%), 1.25 mm (14.11%), 2 mm (0.61%), OM2: 1.50 mm (77.19%), 1.25 mm (22.81%), PDA: 1.75 mm (39.73%), 1.25 mm (25.16%),RV: 1.50 mm (47.61%), 1.25 mm (35.71%), 1.75 mm (16.66%), PLV: 1.50 mm (58.06%), 1.25 mm (35.48%), 1.75 mm (6.45%). There was no statistically significant difference between the groups regarding coronary artery diameters (P>0.05).

Table VII: Distribution of the respondents according to their types of surgery

Types of surgery	Group A (Age: 35 to 50 years) (n=195) f (%)	Group B (Age: 51 to 65years) (n=195) f (%)	P Value
Off pump heart surgery	193(49.49)	189(48.46)	0.284 Not significant
On pump beating heart surgery	2(0.51)	6(1.54)	

Table VII shows, 49.49% of Group A (35-50 years) and 48.46% of Group B (51-65 years) underwent off-pump heart surgery, with minimal cases of on-pump beating heart surgery and no on-pump arrest surgeries; the difference between groups was not statistically significant (P>0.05).

Table VIII: Distribution of the respondents according to their morbidities and mortalities

Variables	Group A (Age: 35 to 50 years) (n=195) f (%)	Group B (Age: 51 to 65 years) (n=195) f (%)	P value
Post-operative morbidities			
AKI	15(7.7)	33(16.9)	[b]0.006[S]
Stroke	2(01)	1(05)	[a]0.624[NS]
LOS	1(0.5)	8(4.1)	[a]0.037[S]
MOF	5(2.6)	8(4.1)	[b]0.397[NS]
Mortality	6(37.5)	10(62.5)	0.307NS

a-Fisher's Exact test, b- Chi square test, S- significant, NS-not significant

Table VIII shows, the incidence of acute kidney injury (AKI) was 7.7% in Group A and 16.9% in Group B, which was significant. Low output syndrome (LOS) occurred in 0.5% of Group A and 4.1% of Group B, also significant. Stroke and multi-organ failure rates were comparable between groups. Mortality was 37.5% in Group A and 62.5% in Group B, with no statistically significant difference (P>0.05). P values were obtained using Fisher's Exact test and chi-square test.

Table IX: Distribution of the respondents according to their association of type of surgery and mortality

Type of surgery	Mortality		Total	P value
	Yes F (%)	No F (%)		
Off Pump beating heart surgery	13(3.4)	369(96.6)	382	0.003[S]
On Pump beating heart surgery	3(37.5)	5(62.5)	8	
On Pump arrest heart surgery	0(0)	0(0)	0	

Table IX shows, 382 patients underwent off-pump beating heart coronary artery bypass grafting, with a mortality rate of 3.4% (13 patients) and a survival rate of 96.6%. For on-pump beating heart surgery, out of 8 patients, 37.5% (3 patients) died and 62.5% survived. The data indicates off-pump surgery may be safer (P=0.003, significant).

Table X: Distribution of the respondents according to their correlation of variables with mortality

Variables	Pearson correlation (Mortality)
Diabetes Mellitus	0.061
Hypertension	0.052
Hyperlipidemia	0.129*
Smoking	0.003
Body mass index	-0.079
Ejection fraction (EF)	0.267**
LV Dysfunction	-0.229**
Left main coronary artery disease	-0.081
Chronic obstructive pulmonary disease (COPD)	0.429**
Bronchial Asthma	0.095
Old myocardial infarction (OMI)	0.291**
Syncope	0.295**
Renal Dysfunction	0.104*
Acute kidney injury (AKI)	0.316**
Stroke	0.426**
Low output syndrome(LOS)	0.399**
Multi organ failure (MOF)	0.898**

*=No significant relationship with mortality, **=weak significant relationship with mortality

Table X shows, Pearson's correlation results indicate, Diabetes Mellitus, Hypertension, Smoking, Bronchial Asthma, No significant relationship with mortality. Hyperlipidemia, Renal Dysfunction, Weak significant relationship with mortality. Ejection Fraction, Old Myocardial Infarction, Syncope, Acute Kidney Injury, Low Output Syndrome, Weak significant relationship with mortality. COPD, Stroke, Moderate significant relationship with mortality. Multi-Organ Failure, Strong very significant relationship with mortality. Body Mass Index and Left Main Coronary Artery have a negative relationship, and LV Dysfunction has a significant negative relationship.

Discussion

The patient population was predominantly male in both groups, with 89.7% males and 10.3% females. This gender distribution was consistent across both age groups and did not show significant statistical differences. Hypertension emerged as the most common risk factor for both groups, with other conditions like diabetes, smoking, and hyperlipidemia varying in prevalence between the two groups. Group A had a higher incidence of diabetes and smoking compared to Group B, while Group B showed higher rates of hypertension. The BMI distribution did not reveal significant differences between the age groups,this study results similar with a study by Janiec M. *et al* (2018).[11]

In terms of functional status, assessed using the New York Heart Association (NYHA) classification, the severity of heart failure symptoms was similar between the two groups, indicating no significant variation in preoperative functional status. Echocardiographic assessments of left ventricular ejection fraction (LVEF) and left ventricular dysfunction also showed no significant differences between the groupsthis study result similar with a study by Fleissneret *et al* (2015).[12]

Coronary angiographic data indicated that both groups had a high prevalence of triple vessel disease (TVD), with similar patterns of coronary artery involvement. The left anterior descending (LAD) artery was the most frequently affected artery in both groups. The extent of coronary vessel involvement did not differ significantly between the groups this

study results similar with a study by Levey AS.*et al* (2005).[13]

Regarding grafting techniques, both age groups predominantly received grafts for the LAD artery, with minimal differences in the grafting of other coronary branches like the diagonal and OM2. The types of conduits used, primarily the left internal mammary artery (LIMA) and greater saphenous vein (GSV), were consistent across both groups, and there were no significant differences in the diameters of the coronary arteries used for grafting.

The surgical techniques were also comparable between the groups, with a majority of surgeries performed off-pump. On-pump beating heart surgery was less common, and no patients underwent on-pump arrest surgery. There were no significant differences between the groups regarding the type of surgical approach this study result similar with an study by Weintraub WS. *et* al (2012).[14]

Postoperative outcomes showed that acute kidney injury (AKI) and low output syndrome were significantly higher in Group B compared to Group A. Despite these differences, overall mortality rates were similar between the groups, with Group A having a mortality rate of 37.5% and Group B 62.5%, though this difference was not statistically significant. The type of surgery did influence mortality rates, with off-pump beating heart surgery associated with lower mortality compared to on-pump beating heart surgery this study results similar with a study by Islam & Majumdar.[15]

Correlation analyses revealed that multi-organ failure had a strong relationship with mortality, while chronic obstructive pulmonary disease (COPD) and stroke had a moderate relationship. Hyperlipidemia and renal dysfunction had weak but significant correlations with mortality. Ejection fraction, old myocardial infarction, syncope, AKI, and low output syndrome also showed weak but significant relationships with mortality. BMI and left main coronary artery disease had a negative relationship with mortality, and left ventricular dysfunction had a significant negative relationship this study results similar with a study by Manganas H. *et al* (2007).[16]

Overall, the study provides insight into the patterns of disease, graft usage, and outcomes of CABG procedures, emphasizing the importance of tailored surgical and postoperative care to improve patient outcomes. The findings highlight the need for individualized management strategies based on patient age and clinical conditions to optimize CABG results.

Conclusion

This study concludes that CABG patients are predominantly male, with hypertension being the most common risk factor and hyperlipidemia the least. Off-pump beating heart surgery was common in both groups, with no significant difference in mortality rates. Post-operative stroke and multi-organ failure were rare, but acute kidney injury and low output syndrome were more frequent in the older group. Mortality was strongly associated with multi-organ failure and moderately with COPD and stroke, while other factors showed weak or no significant relationships.

Recommendation

Off-pump surgery should be prioritized when feasible and very close attention and intensive postoperative care management should be need for all patient especially patients with multi-organ failure, COPD, stroke, AKI, and LV dysfunction. It should be important to control hyperlipidemia and renal dysfunction to improve the overall survival outcomes. By

ensuring strict post-CABG management and follow-up particularly in those with LV dysfunction, can help to reduce long term complications and mortality.

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