Coronary Artery Bypass Grafting in Young Adults

Hina Inam[1], Abdul Ahad Sohail[1], Aiman Aamir[1], Kaleem S. Ahmed[1], Narmeen Asif[2] and Syed Shahabuddin Sharfuddin[1]

[1]*Department of Cardiothoracic Surgery, The Agha Khan University Hospital, Karachi, Pakistan*
[2]*Department of General Surgery, The Agha Khan University Hospital, Karachi, Pakistan*

ABSTRACT

Objective: To evaluate the risk factors for early onset of coronary artery disease (CAD) and assess the preoperative presentation, perioperative course, survival, and short-term complications after coronary artery bypass graft (CABG) in patients aged 45 years or younger undergoing CABG.

Study Design: Observational study.

Place and Duration of the Study: Department of Cardiothoracic Surgery, The Aga Khan University Hospital, Karachi, Pakistan, from December 2020 to January 2021.

Methodology: All patients aged 45 years or younger who were undergoing CABG were included in the study. Patients with incomplete medical records were excluded. Study variables included preoperative demographic information, intraoperative variables including the number and type of conduits used, and postoperative morbidity and mortality. Descriptive analysis was reported for all variables.

Results: The study population cohort included 134 patients, of whom 120 (89.6%) were male, with a mean age of 38.6 ± 5.1 years (range: 30-45 years). The indication for surgery was 3-vessel CAD in 56 (41.7%) patients. A total of 421 grafts were constructed, with a mean of 3.14 grafts per patient. One patient died in the hospital with an overall operative mortality of 1.5%. The most common risk factors were found to be family history, the presence of diabetes mellitus, hypertension, and smoking.

Conclusion: The risk factors and outcomes in younger patients (less than 45 years) undergoing CABG are not markedly different from those in older patients and are comparable to the existing literature.

Key Words: *Coronary artery disease, Coronary artery bypass graft, Young adults, Risk factors, Three vessel disease.*

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INTRODUCTION

Coronary artery disease (CAD) is usually considered as a disease of the elderly.[1] However, the incidence of CAD including acute coronary artery syndromes has shown to have increased in recent years in middle to young age adults.[2,3] The prevalence reported in the literature ranges from 1-10% for CAD in young adults with an incidence of 18.9% under the age of 60 years to 5.2% under the age of 50 years.[4-7] Young adults have been defined differently in the literature and as far as the age is concerned, it may be as low as patients under the age of 45 years who present with CAD with an incidence of about 3%.[8,9] Premature CAD can present as a rapidly progressive form of the disease, with an aggressive onset of symptoms requiring revascularisation or emergency intervention more frequently in younger patients than in the elderly.[6,10,11] Multiple studies have shown increased incidence of premature CAD with extensive disease in patients from the Indian subcontinent.[8]

Correspondence to: Dr. Abdul Ahad Sohail, Department of Cardiothoracic Surgery, The Agha Khan University Hospital, Karachi, Pakistan
E-mail: abdulahad7@hotmail.com

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Younger patients presenting with CAD have a relatively lower prevalence of conventional risk factors, such as diabetes mellitus and hypertension. However, increased incidence of smoking, male gender, and family history of premature CAD were observed in 71%, 94%, and 27% of patients, respectively as reported by Christus *et al.*[8,12] The incidence of left main disease or triple vessel CAD has been reported to be about 15%.[8] Although younger patients should be managed with medical therapy or percutaneous coronary intervention (PCI), leaving CABG for later stages of life, coronary artery bypass grafting (CABG) is the standard procedure where indicated, especially performed for left main, unprotected left main, and a triple vessel CAD.[1] CABG in young patients is reported to have an excellent overall outcome, lower mortality, and better 5-year survival.[4,8] It has proved to be more durable with lower rates of repeated revascularisation as compared to older patients and higher freedom from major adverse cardiac and cerebrovascular events.[6,10]

Hence, the objective of this study was to evaluate the risk factors for early onset of CAD in patients aged 45 years or younger undergoing CABG, and assess the preoperative presentation, perioperative course, survival, and short-term complications after CABG in this group of patients.

METHODOLOGY

It was a retrospective observational study, carried out at the Department of Cardiothoracic Surgery, the Aga Khan University

Hospital, Karachi, Pakistan from January 2001 to December 2020. All patients aged 45 years or younger who were undergoing CABG were included in the study. Patients with incomplete data were excluded. Variables of interest included preoperative characteristics pertaining to demography and comorbid factors. Intraoperative information was cross-clamp time (CCT), cardiopulmonary bypass (CPB) time, duration of the procedure, type of graft / conduits that is left internal thoracic artery (LITA), radial artery, and reverse saphenous vein graft (RSVG), and number of grafts. Similarly, postoperative outcomes in terms of morbidity and mortality were recorded. Patients' information was collected on structured proforma from their medical record files having sections for the above variables. The Ethical Review Committee (ERC) of the University Hospital approved the study.

Standard operative discipline was followed in all cases. All the procedures were performed with median sternotomy and establishment of CPB by cannulating distal ascending aorta and right atrium after the procurement of conduits and full heparinisation that is 300 units/kg. Distal coronary anastomoses were constructed on a still heart under cardioplegic arrest while proximal ends to the aorta were completed using the partial occluding clamp. Heart was then allowed to perfuse and weaned-off CPB. Subsequently, chest closure was performed after securing haemostasis, placement of drains, and pacing wires.

Statistical analysis was done using SPSS version 23. Descriptive analysis was reported for all variables. Mean ± standard deviation / median ± interquartile range (IQR) was calculated for all quantitative variables. Frequency and percentages were reported for all the categorical variables.

RESULTS

The study population cohort comprised of 134 patients, aged 45 years or younger who underwent a CABG between January 2001 and December 2020. Among these patients, 120 (89.6%) were male, with a mean age of 38.6 ± 5.1 (30-45) years and all were operated on during this time period. One hundred and one patients (75.37%) presented with Class III/IV angina; 121 (90.2%) had previously suffered a myocardial infarction and 33 (26.83%) had impaired left ventricular ejection fraction (LVEF) <45% as shown in Table I.

Hypertension was the most prevalent risk factor for CAD and was observed in 60.5% of the cases, followed by a family history of CAD (53.0%), diabetes mellitus (51%), and a history of smoking (43.3%). The indication for surgery was 3-vessel disease in 56 (41.7%) patients, 2-vessel disease in 10 (7.5%), and single-vessel disease in 2 (1.5%).

A total of 421 grafts were constructed, with a mean of 3.14 grafts per patient. The type and number of grafts per patient are summarised in Table II. A total of 97.15% of patients had at least one arterial graft, most commonly the left internal thoracic artery (LITA). Surgery was performed under extracorporeal circulation with a mean CPB time of 97.4 ± 31.9 minutes. Of the operations, 85.8% were elective, 6.7% were urgent, and 7.5% were emergent, with a mean operative time of 206.1 ± 76.4 minutes. The routine approach involved using a LITA graft for the left anterior descending artery, and a reverse saphenous vein graft (RSVG) or radial artery (RA) graft for the circumflex artery or its branches, if the anatomical configuration permitted, and an RSVG or RA graft was used for the right coronary artery or its branches (Table II).

One patient died in hospital with an overall operative mortality of 0.74%. Another 4.6% required re-intervention within the same hospital stay and / or within 30 days of surgery for procedure-related complications. Mean hospital stay was 8.4 ± 6.7 days for the patients. The follow-up extended to a total of cumulative 20 patient-years (Figure 1).

Table I: Preoperative characteristics of the patient undergoing CABG (n = 134).

Variable	Sub-variable	Frequency	Percentage (%)	Mean	SD
Height				166.58	8.87
Weight				77.61	13.89
Gender	Male	120	89.55		
	Female	14	10.45		
History of angina		101	75.37		
Family History of CAD (Coronary artery disease)		71	53		
LVEF (Left Ventricular ejection fraction)				50.79	15.61
History of PAD (Peripheral artery disease)		3	2.26		
MI (Time since onset of symptoms)	<24 hours	11	8.33		
	<1 week	21	15.91		
	<1 month	59	44.7		
	>1month	41	31.06		
Comorbids	HTN	81	37.33		
	DM	51	23.50		
	Smoker (Current)	39	17.97		
	Smoker (Past)	19	8.76		
	CKD (Chronic kidney disease)	5	2.30		
	AKI (Acute kidney injury)	4	1.84		
	None	18	8.29		

Table II: Operative information of the patients.

Variable	Sub-variable	Frequency	Percentage	Mean	SD
Number of grafts			3.14	0.98	
Surgery type	Elective	115	85.82		
	Urgency	9	6.72		
	Emergency	10	7.46		
Use of IABP (Intra-aortic balloon pump)	Postoperative	3	2.24		
	Preoperative	5	3.72		
	Not used	120	94.03		
Cardiac Redo		1	0.75		
CPB (min)				97.36	31.91
CCT (min)				61.68	26.18
Anaesthesia	General	100	100		
Re-intervention		6	4.62		
Grafts used	LITA + RSVG	119	74.84		
	Arterial alone	12	7.55		
	LITA + Arterial	11	6.92		
	LITA alone	7	4.40		
	LITA + Sequential	4	2.52		
	RSVG alone	4	2.52		
	LITA + RITA	2	1.26		
Duration of surgery (min)	Mean			206.08	76.41

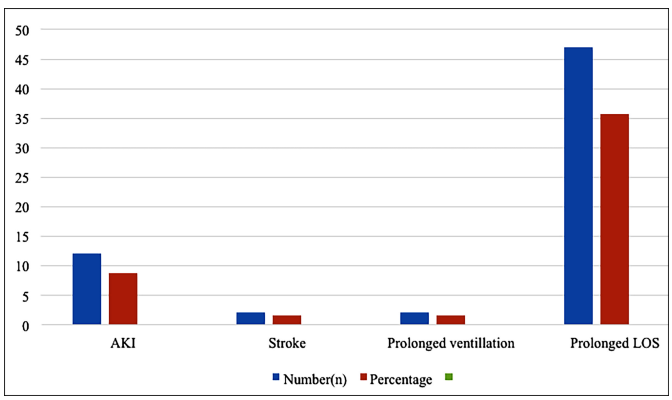

Figure 1: Postoperative complications in young adults undergoing CABG.

DISCUSSION

CAD manifesting prematurely in young adults can have severe and devastating consequences on the overall lifestyle of the patients and their families.[13,14] Recent literature has suggested that premature CAD has become more prevalent in the Indian subcontinent as compared to other regions.[8] However, as with older age groups, single-vessel disease has a higher prevalence than triple-vessel disease requiring revascularisation with either PCI or CABG in a significant number of young patients.[8,15]

The mean age of the patients requiring CABG was 38.6 ± 5.1 years. Almost 90% of them were male. Similarly, in a study published by Christus *et al.*, the mean age was further low which was 31.69 ± 3.76 years with 94% of males having CAD and 45.5% of these patients required revascularisation with either PCI (32%) or CABG (13.5%).[8] The mean age of young patients studied by Konishi *et al.* in the Japanese population was more similar to the study which was 36.1 ± 4.9 years, with an even increased number (96%) of male patients.[5] Multiple recent studies have defined different upper age limits for including CAD patients in young category ranging from 35-50 years. However, the mean age of patients presenting with premature CAD remains similar from the early to mid-thirties varying from region to region.[5,6,8] However, Rosato *et al.* demonstrated that the overall prevalence of CAD in patients less than 50 years was 5.2% which decreased to 0.5% in patients less than 40 years.[6]

In this study, the most common risk factors associated with premature CAD were hypertension observed in 60.5% of patients, family history in 53% of patients, DM in 51%, and smoking in 43.3% of patients. Another interesting preoperative finding in these patients was a history of prior MI as high as 90.2%. In contrast to this, recent studies conducted in Kuwait and Japan demonstrated conflicting results with smoking as the greatest risk factor for CAD in young patients, followed by a previous history of MI, with DM and HTN being a risk factor in only 17-20% of patients.[5,8] However, the most common risk factor remained the same in all studies throughout the literature including this study which was the male gender for premature CAD with a less aggressive form of CAD in women.[4,16,17]

Young patients presenting with CAD and requiring revascularisation, require a durable solution to prevent further major cardiovascular events or symptoms, freedom from repeated

revascularisation, and provide a good quality of life.[6,18] Multiple recent studies show CABG as the more durable procedure with greater freedom from repeated revascularisation, MACCE, and lower long-term mortality and morbidity, especially in patients less than 50 years of age as compared to the elderly patients.[2,4,6] This study demonstrated that about 26.83% of patients had a low left ventricular ejection fraction (LVEF) of less than 45% which is similar to a study by Christus *et al.*, which showed 30.3% of patients had ejection fraction (EF) less than 50%.[8] The mean number of grafts used per patient was 3.14 in this study, aligning with findings in the literature for CABG in young patients, which was 2.57 grafts per patient. The most commonly used arterial graft in this study was the left internal thoracic artery, with radial grafts used in 7.55% of patients.

Although this study only demonstrated short-term mortality and morbidity of CABG in young patients, encouraging results were seen with only one in-hospital mortality, 0.74% 30-day mortality, and only 4.6% of patients having procedure-related perioperative morbidity requiring reintervention. This was comparable to recent literature which showed 0.4-0.5% 30-day mortality in young patients aged less than 50 years, as compared to the elderly population undergoing CABG.[4,6,19] However, this study demonstrated a slightly higher rate of acute kidney injury of 8.8% in young patients, as well as an increased duration of stay of exceeding 7 days in about 35% of patients. This may be due to the aggressive nature of the disease in the young population and early surgical intervention in more than half of the patients after myocardial infarction, not allowing enough time for the myocardium recovery.

To the authors' knowledge, this is the first study evaluating the results in this important group of young patients undergoing CABG in this region. However, the study has some potential limitations including its retrospective nature and a single centre setting. Additionally, it was observed that the use of multiple arterial graft is too low despite an average graft number of more than three. Hence, the results may not be generalisable to population at large, as the risk profiles and variable management strategies may vary in these young patients.

CONCLUSION

The most common risk factors in this cohort were found to be family history, the presence of diabetes mellitus, hypertension, and smoking. It is reassuring that despite the aggressive nature of the disease and multiple risk factors the outcomes are comparable as highlighted in the existing literature. However, the authors suggest a multicentre study having a large sample size and use of multi-arterial grafting to be conducted to look at long-term follow-up of patients with premature CAD undergoing CABG. This would help determine their survival, long-term freedom from MACCE, and repeated revascularisation procedures.

ETHICAL APPROVAL:
Ethical approval was taken from the Ethical Review Committee of the Aga Khan University Hospital, Karachi, Pakistan (ERC# 2020-4981-14573).

PATIENTS' CONSENT:
All patients' consent was taken before being included in the study. Patients' confidentiality was maintained.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
HI, AAS, AA, KSA, NA, SSS: Conception and design, data collection, analysis, and drafting of the manuscript.
All authors approved the final version of the manuscript to be published.

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