

Original Research Article

Age and off-pump coronary artery bypass grafting: assessing surgical outcomes in elderly patients - a single-center perspective study

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ABSTRACT

Background: Coronary artery disease (CAD) remains a major global burden, increasingly affecting the elderly and requiring effective interventions like coronary artery bypass grafting (CABG). Off-pump CABG (OPCABG) has gained popularity as a technique that avoids cardiopulmonary bypass, reducing perioperative complications such as stroke and inflammatory responses. The impact of advanced age on OPCABG outcomes remains a critical area of investigation.

Methods: This comparative cross-sectional study was conducted in the Department of Cardiac Surgery at Bangladesh Medical University from January to December 2024, including 100 patients undergoing OPCABG, divided into two groups: patients younger than 65 years (n=50) and those older than 65 years (n=50).

Results: Data analysis revealed significant differences in post-operative outcomes, with elderly patients experiencing prolonged ventilation time (449.6 ± 31.5 min versus 303.1 ± 35.4 min, $p < 0.05$), increased postoperative bleeding (450.6 ± 81.3 ml versus 316.4 ± 69.3 ml, $p < 0.05$), and higher serum creatinine levels on the first postoperative day (1.9 ± 0.2 mg/dl versus 1.5 ± 0.3 mg/dl, $p < 0.05$). Psychosis was more prevalent in the older cohort (4 versus 1 case, $p = 0.02$), along with higher rates of wound infections after the fifth postoperative day (9 versus 2 cases, $p = 0.03$) and respiratory tract infections in the ICU (8 versus 1 case, $p = 0.01$).

Conclusions: Despite similar preoperative profiles, elderly patients faced more complications, highlighting the influence of age-related physiological changes on post-operative recovery. These findings highlight the need for optimized ventilation, strict infection control, and personalized postoperative care in elderly OPCABG patients.

Keywords: Off-pump CABG, CABG, Age-related CABG outcome, Psychosis in post-CABG patients

INTRODUCTION

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality worldwide, with 315 million prevalent cases reported in 2022.¹ The burden of CAD is not uniform across different regions, with Central and Eastern Europe and Central Asia exhibiting the highest age-standardized prevalence rates (8019 per 100,000), while South Asia has the lowest (2393 per 100,000).¹ The pathogenesis of CAD is influenced by numerous risk factors, including advanced age, chronic comorbidities

such as diabetes mellitus, hypertension, and renal dysfunction, as well as cardiac conditions like congestive heart failure and previous myocardial infarctions.² Factors such as obesity, female gender, and the presence of a calcified ascending aorta further contribute to the complexity of CAD and its management.² As CAD progresses, surgical interventions such as coronary artery bypass grafting (CABG) become necessary to restore myocardial perfusion.

CABG is a well-established surgical procedure aimed at bypassing obstructed coronary arteries to improve blood

flow to the heart muscle.³ Traditionally, CABG has been performed using cardiopulmonary bypass (on-pump CABG), which allows the surgeon to operate on a still heart with the aid of a heart-lung machine.⁴ The evolution of surgical techniques has led to the development of off-pump coronary artery bypass grafting (OPCABG), which is performed on a beating heart without the use of cardiopulmonary bypass.⁵ OPCABG is made possible through technological advancements such as intracoronary shunts and epicardial stabilization devices, which facilitate precise graft placement while minimizing hemodynamic disturbances.⁶ Compared to conventional CABG, OPCABG is associated with reduced incidence of stroke, lower transfusion requirements, and decreased oxidative stress and inflammation, making it particularly beneficial for high-risk patients, including the elderly.^{7,8}

Despite its advantages, OPCABG is not without limitations, particularly in elderly patients who often present with diminished functional reserves and multiple comorbidities.⁹ Aging is associated with a decline in pulmonary, renal, and nervous system function, as well as vascular stiffness and increased oxidative stress, all of which heighten the risks associated with major cardiac surgery.^{6,10} Studies have shown that elderly patients undergoing CABG, regardless of the technique used, face higher rates of postoperative complications, prolonged hospital stays, and increased mortality compared to younger patients.^{11,12} The technical challenges of OPCABG, such as performing anastomoses on a beating heart, may result in incomplete revascularization and a higher need for repeat revascularization procedures in some cases.¹³

Given these complexities, the impact of advanced age on OPCABG outcomes remains a crucial area of investigation. While OPCABG offers significant advantages in reducing perioperative complications and facilitating early recovery, its efficacy in elderly populations requires further evaluation. This single-center study aims to assess the outcomes of OPCABG in elderly patients, addressing key questions regarding its safety, effectiveness, and long-term benefits in this high-risk cohort. By providing insights into age-related surgical risks and recovery patterns, this research seeks to contribute to the optimization of cardiac surgical strategies for an aging population.

METHODS

This comparative cross-sectional study was conducted in the Department of Cardiac Surgery at Bangladesh Medical University over a one-year period from January 2024 to December 2024. A total of 100 patients undergoing off-pump CABG were included, with 50 patients in each age-defined cohort. This study included patients over 18 years undergoing routine CABG at Bangabandhu Sheikh Mujib Medical University (BSMMU). Those with prior cardiac surgery, hemodynamic instability, emergency CABG, conversion to on-pump, previous stroke, chronic renal

insufficiency, or cardiac malignancy were excluded. Patient selection followed a purposive sampling method, relying on the clinical expertise and judgment of individual surgeons, without randomization. This study adhered to the Helsinki Declaration (2011), ensuring ethical integrity through informed consent, voluntary participation, and data confidentiality. Institutional and departmental approvals from IRB of BSMMU were obtained before starting the research.

A standard median sternotomy was performed to expose the heart, allowing optimal access for off-pump coronary artery bypass grafting. The coronary arteries were exposed using a single suture placed in the oblique sinus of the posterior pericardium, facilitating elevation and lateral displacement of the beating heart. To ensure adequate visualization of the posterior wall, four deep pericardial retraction sutures were anchored, creating a stable surgical field. Coronary stabilization was achieved using either a compression-type device or a suction device, the latter proving particularly advantageous in combination with retropericardial sutures, allowing bypass grafting on any surface of the heart while maintaining its natural rhythm. Coronary flow interruption was initially achieved by gently snaring the vessel with silicone loops, while an intracoronary shunt is introduced after arteriotomy to maintain distal perfusion, enhance visualization, and reduce technical errors. The left internal thoracic artery (LITA) was most commonly anastomosed to the left anterior descending artery (LAD), with additional revascularization using saphenous vein and radial artery grafts as needed. LITA-LAD anastomosis was consistently performed first, aided by room air blowing (<5 l/min) to enhance visibility. Distal anastomosis was prioritized for vessels supplying the left ventricle, followed by revascularization of the dominant coronary system. Proximal anastomosis was then constructed on the ascending aorta using lateral occlusion clamping. To assess graft patency, transit time flow measurement (TTFM) was employed, allowing real-time evaluation of graft function after each distal anastomosis. Once all grafts were completed, heparinization was reversed with protamine. Hemodynamic stability was carefully maintained, with arterial hypotension managed using alpha-agonists and ST-segment depression addressed with nitroglycerin, ensuring optimal postoperative outcomes.

Data collection was carried out using a standardized semi-structured data sheet, ensuring confidentiality and ethical integrity. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 29.0, with data presented as means±standard deviation or frequencies, and comparisons assessed through unpaired student's t-test, Chi-square test and Fisher's exact test, considering a p value <0.05 as statistically significant.

RESULTS

In Table 1, the pre-operative characteristics of the two age groups (<65 years and >65 years) were analyzed to ensure

comparability between them. The distribution of sex, smoking history, and comorbidities, including hypertension, diabetes mellitus, and cardiovascular disease, showed no statistically significant differences ($p>0.05$). Laboratory parameters such as hemoglobin level, serum creatinine, and random blood sugar were similar across both groups. The prevalence of double and triple vessel disease was also comparable. Given the absence of significant baseline differences, the two groups are well-matched, allowing for a valid comparison of surgical outcomes without the influence of pre-existing disparities.

Table 1: Pre-operative characteristics.

Variables	Age <65 years	Age >65 years	P value
Sex			
Male	39	35	0.36
Female	11	15	
Smoking history			
Yes	30	26	0.42
No	20	24	
Comorbidity			
Hypertension	37	34	0.51
Diabetes mellitus	19	21	0.68
CVD	4	6	0.50
Hb level (mg/dl)	12.6±0.3	12.5±0.5	0.11
S. creatinine level (mg/dl)	1.1±0.2	1.2±0.2	0.15
RBS (mmol/l)	8.1±1.2	8.3±1.0	0.18
Number of double vessels disease	15	10	0.25
Number of triple vessels disease	35	40	0.25

Table 2: Post-operative outcomes.

Variables	Age <65 years	Age >65 years	P value
Total ventilation time (min)	303.1±35.4	449.6±31.5	<0.05
Bleeding in 1st 24 hours in ICU (ml)	316.4±69.3	450.6±81.3	<0.05
S. creatinine level in 1st POD (mg/dl)	1.5±0.3	1.9±0.2	<0.05
Psychosis	1	4	0.02
Wound infection after 5th POD	2	9	0.03
RTI in ICU	1	8	0.01

In Table 2, the post-operative outcomes reveal significant differences between the two age groups, indicating a greater burden of complications in patients older than 65 years. Prolonged ventilation time, increased postoperative bleeding, and higher serum creatinine levels on the first postoperative day were observed in the older group ($p<0.05$), suggesting a more challenging recovery process.

Additionally, psychosis, wound infections after the fifth postoperative day, and respiratory tract infections in the ICU were notably more frequent in the older group, further highlighting their vulnerability ($p<0.05$). These findings suggest that advanced age is associated with higher postoperative morbidity, necessitating closer monitoring and tailored perioperative care strategies.

DISCUSSION

Our study's preoperative sex distribution, with 74% males and 26% females, closely aligns with previously documented patterns, albeit with slight variations. The predominance of male patients undergoing off-pump CABG has been well established, with reported male proportions ranging from 51.7% to 79%.^{9,10} The female representation in our study (26%) fits within the spectrum outlined in prior investigations.^{8,9} Differences in gender distribution across studies may be influenced by demographic trends, socio-economic factors, referral biases, and disparities in healthcare accessibility. Preoperative comorbidities in our study reflect broader trends documented in the literature, with variations that are worth further exploration. Our reported smoking prevalence of 56% positions itself between findings from different research efforts, with rates ranging from 52.1% to 74%.^{14,15} This variability may reflect the evolving landscape of public health initiatives and shifting societal attitudes toward smoking, particularly among older populations. Hypertension was present in 71% of our cohort, comparable to the 62.5% and 43% reported in certain studies, yet lower than findings of 87.3% observed elsewhere.^{8,9,13} Such variations likely stem from differences in healthcare access, early screening programs, and lifestyle factors across populations. Diabetes mellitus prevalence in our study (20%) was consistent with the 15.1% to 23% range reported in different analyses, though significantly lower than the 42.4% documented in some reports.^{9,13,16} This disparity may highlight regional dietary influences, genetic predispositions, and improvements in diabetes management over time. Hemoglobin levels remained nearly identical between the two groups (12.6±0.3 mg/dl versus 12.5±0.5 mg/dl), diverging from the lower levels (8.5 mg/dl) reported in some studies, potentially due to population-based differences.¹⁵ Serum creatinine was slightly elevated in the older cohort (1.2±0.2 mg/dl versus 1.1±0.2 mg/dl), a finding that corresponds with reports highlighting higher creatinine levels in elderly patients.¹⁷ Random blood sugar levels showed minimal variation (8.1±1.2 mmol/l versus 8.3±1.0 mmol/l), resonating trends observed in existing literature.¹⁸ Double-vessel disease was more prevalent in patients under 65 years (15 cases) compared to those over 65 years (10 cases), paralleling previous findings where a 19.7% prevalence was noted.¹³ Our results were slightly lower than the 17% prevalence reported in separate analyses, indicating potential influences of population-specific characteristics and regional healthcare patterns.¹⁵ Triple-vessel disease was more common in the older cohort (40 versus 35 cases), a trend consistent with prior

studies reporting an 81% prevalence.¹⁵ This still fell below the 73.6% prevalence documented elsewhere.¹³ These subtle variations may be attributed to differences in patient demographics, clinical decision-making, and variations in the assessment of disease severity across multiple studies.

In our study, patients over 65 years experienced significantly prolonged total ventilation time (449.6 ± 31.5 minutes) compared to their younger counterparts (303.1 ± 35.4 minutes), a trend that aligns with previous research documenting even longer durations, such as 636 minutes and 504 minutes.^{6,8} This finding highlights the respiratory challenges faced by elderly patients, likely due to age-related physiological changes and pre-existing comorbidities. Psychosis was observed in four elderly patients, compared to just one in the younger cohort ($p=0.02$), reinforcing the well-documented susceptibility of older individuals to postoperative cognitive disturbances. This pattern mirrors findings from prior investigations, which have reported notably higher psychosis rates (38.5%) among elderly post-surgical patients.¹⁹ Wound infections were more prevalent in the older group (9 versus 2 cases, $p=0.03$), a disparity that may be attributed to age-related impairments in tissue healing, a phenomenon consistently highlighted in past clinical analyses.² Respiratory tract infections (RTIs) were significantly more frequent in elderly patients (8 versus 1 case, $p=0.01$), emphasizing their increased vulnerability to postoperative infections. Similar findings have been noted in studies examining post-surgical infection risks, particularly among aging populations with diminished immune responses.¹⁷

Limitations

One limitation of our study is the retrospective design, which may introduce selection bias due to the non-randomized patient cohort and reliance on surgeons' clinical judgment. The single-center setting may limit the generalizability of our findings to broader populations or diverse healthcare systems. The absence of long-term follow-up data restricts the assessment of sustained outcomes beyond the immediate postoperative period.

CONCLUSION

This study highlights the impact of age on post-operative outcomes in patients undergoing off-pump CABG, revealing longer ventilation times, higher infection rates, and increased complications in the elderly cohort. While both age groups demonstrated comparable pre-operative characteristics, the post-operative differences highlight the need for tailored perioperative management strategies for older patients. The findings align with existing literature, reinforcing the influence of age-related physiological changes on surgical recovery. Optimizing preoperative assessment and post-operative care in elderly patients may improve outcomes and enhance recovery. Further research with larger cohorts and multicenter data is warranted to refine surgical strategies and enhance patient care.

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