EJPMR, 2026, 13(8), 795-799 **Research Article** **Impact Factor: 8.158**

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

ISSN (O): 2394-3211
ISSN (P): 3051-2573
Coden USA: EJPMAG

CLINICAL CHARACTERISTICS AND EARLY OUTCOMES OF PATIENTS AGED 70 YEARS AND OLDER UNDERGOING CORONARY ARTERY BYPASS GRAFTING

Hasan Al Imran[1,2], Wei Wang*[1,2]

[1]Department of Cardiovascular Surgery, The Affiliated Hospital of Yangzhou University, Yangzhou, 225001 Jiangsu China.
[2]Clinical Medical College, Yangzhou University, Yangzhou, 225001 Jiangsu China.

***Corresponding Author: Wei Wang**

Department of Cardiovascular Surgery, The Affiliated Hospital of Yangzhou University, Yangzhou, 225001 Jiangsu China. **DOI:** https://doi.org/10.5281/zenodo.22095346

How to cite this Article: Hasan Al Imran[1,2], Wei Wang*[1,2]. (2026). Clinical Characteristics and Early Outcomes of Patients Aged 70 Years and Older Undergoing Coronary Artery Bypass Grafting. European Journal of Pharmaceutical and Medical Research, 13(8), 795–799.

Article Received on 01/07/2026 **Article Revised on 20/07/2026** **Article Published on 01/08/2026**

ABSTRACT

Background: Coronary artery bypass grafting (CABG) is an effective treatment for coronary heart disease, yet its safety in elderly patients (aged >70 years) remains a subject of debate. This study evaluated the clinical profiles and short-term mortality in elderly patients undergoing on-pump versus off-pump CABG. **Methods:** We retrospectively analyzed 124 patients aged 70–83 years who underwent first-time CABG at The Affiliated Hospital of Yangzhou University between January 2018 and December 2023. Patients were divided into on-pump (n=92) and off-pump (n=32) groups. Preoperative, intraoperative, and postoperative outcomes were compared. Statistical analyses employed t-tests and χ^2 tests, with $P<0.05$ considered significant. **Results:** Preoperative comorbidities were prevalent, with hypertension (75.8%) and three-vessel disease (64.5%) significantly more common in the on-pump group ($P<0.01$). The left internal mammary artery was used in 56.5% of patients and complete revascularization achieved in 81.5%, both significantly higher in on-pump surgery ($P<0.01$). Postoperative outcomes, including mechanical ventilation duration (12.3±3.5 hours), ICU stay (3.8±1.5 days), and total hospital stay (18.7±6.9 days), did not differ significantly between groups. Pleural effusion was more frequent after off-pump CABG (21.9% vs. 4.3%, $P<0.01$). In-hospital mortality was 4.8%, with no significant between-group difference ($P>0.05$). Pulmonary infection was the most common complication (15.3%). **Conclusions:** Both on-pump and off-pump CABG appear safe in elderly patients, with comparable short-term mortality. The higher rates of hypertension, stroke history, and three-vessel disease in on-pump patients suggest this approach may be preferred for more complex cases. Comprehensive perioperative management remains essential in this vulnerable population.

KEYWORDS: Coronary artery disease; off-pump coronary artery bypass grafting; selection of operative technique; perioperative management.

INTRODUCTION

Coronary atherosclerotic heart disease (coronary heart disease) is a common cardiovascular disorder caused primarily by atherosclerotic lesions of the coronary arteries. These lesions narrow or obstruct the vascular lumen and can lead to myocardial ischemia, hypoxia, and necrosis; severe disease may even result in sudden death. Coronary artery bypass grafting (CABG) is an effective method for restoring coronary blood supply to ischemic myocardium.[1-3] According to statistics from the Society of Thoracic Surgeons (STS), the proportion of elderly patients among those undergoing CABG has increased year by year.[4] Age over 70 years is regarded as an independent risk factor for conventional CABG.[5] This study aimed to investigate the influence of advanced age on the safety of CABG and on perioperative management.

METHODS

Study Population

Patients who underwent CABG at The Affiliated Hospital of Yangzhou University, between January 2018 and December 2023 were reviewed. The inclusion criteria were as follows: age over 70 years; a definite

preoperative diagnosis of coronary heart disease; first-time CABG; use of nitrate therapy for more than 1 month before surgery to relieve and control angina; use of β-blockers to control the heart rate at 60-80 beats/min; routine discontinuation of antiplatelet agents for more than 5 days before surgery, with low-molecular-weight heparin used as replacement therapy; and performance of the operation in accordance with surgical guidelines, with an arterial graft used whenever possible. The exclusion criteria were cardiac insufficiency, left ventricular ejection fraction <30%, chronic obstructive pulmonary disease, and chronic renal insufficiency.

Based on published reports, screening variables were identified and a data collection form was developed to obtain the clinical information of all patients. Patients were divided into on-pump and off-pump groups according to the surgical technique. Preoperative baseline characteristics, intraoperative information, and postoperative outcomes were compared between the groups. Preoperative variables included age, sex, body mass index [weight (kg)/height (m)²], hypertension, diabetes mellitus, stroke, previous myocardial infarction, renal insufficiency, New York Heart Association (NYHA) functional class, left ventricular ejection fraction, and coronary angiographic findings. Intraoperative variables included the number of grafts, number of distal anastomoses, use of the left internal mammary artery, achievement of complete revascularization, aortic cross-clamp time, cardiopulmonary bypass time, and duration of surgery. Postoperative variables included duration of mechanical ventilation, length of intensive care unit (ICU) stay, total postoperative drainage volume, postoperative complications, length of hospital stay, and in-hospital mortality.

Diagnostic Criteria

Type 2 diabetes mellitus was diagnosed according to the Chinese Guidelines for the Prevention and Treatment of Diabetes (2007 edition).[6] Diabetes was diagnosed when any one of the following criteria was met: (1) symptoms of diabetes and a random plasma glucose concentration ≥11.1 mmol/L; (2) fasting plasma glucose >7.0 mmol/L; or (3) 2-hour postprandial plasma glucose ≥11.0 mmol/L. Coronary angiography was performed using the Judkins multi-projection technique. Multivessel coronary disease was diagnosed when at least two major coronary arteries or their major branches (diameter ≥2.5 mm) were involved, visually estimated diameter stenosis was ≥50%, and at least one vessel had diameter stenosis ≥70%.

Statistical Analysis

Statistical analyses were performed using SPSS version 22.0. Continuous data are presented as mean ± standard deviation and were compared between groups using the t test. Categorical data are presented as relative numbers and were compared using the χ^2 test. A value of $P < 0.05$ was considered statistically significant.

RESULTS

A total of 124 elderly patients aged over 70 years were included, comprising 82 men and 42 women. Their ages ranged from 70 to 83 years, with a mean of 74.5 ± 7.1 years. 92 patients underwent on-pump CABG and 32 underwent off-pump CABG. Mean age, sex, and body mass index did not differ significantly between the two groups ($P > 0.05$). Preoperative comorbidities included hypertension, diabetes mellitus, stroke, previous coronary stenting, previous myocardial infarction, renal insufficiency, and impaired cardiac function. Hypertension and stroke were more common among patients undergoing on-pump CABG, with highly significant between-group differences ($P < 0.01$); the other comorbidities did not differ significantly between groups ($P > 0.05$). Preoperative data showed that 64.5% of the elderly patients had three-vessel coronary disease, and the proportion treated with on-pump CABG was significantly higher than that treated with off-pump CABG ($P < 0.01$) (Table 1).

Intraoperative Findings

Overall, the left internal mammary artery was used in 70 elderly patients (56.5%), and complete revascularization was achieved in 101 patients (81.5%). Both were more common in the on-pump CABG group, with highly significant between-group differences ($P < 0.01$). In the on-pump CABG group, the aortic cross-clamp time and cardiopulmonary bypass time were 67.8 ± 18.1 minutes and 125.9 ± 33.2 minutes, respectively. The number of grafts, number of distal anastomoses, and duration of surgery did not differ significantly between groups ($P > 0.05$) (Table 2).

Postoperative Outcomes

Overall, the mean duration of postoperative mechanical ventilation was 12.3 ± 3.5 hours, the mean ICU stay was 3.8 ± 1.5 days, and the mean total postoperative drainage volume was 548.2 ± 74.6 mL. None of these outcomes differed significantly between the two groups ($P > 0.05$). Complications after CABG in elderly patients included low cardiac output, perioperative myocardial infarction, re-exploration for bleeding, pulmonary infection, pleural effusion, and atrial fibrillation. Pleural effusion was more common after off-pump CABG, with a significant between-group difference ($P < 0.01$); the other postoperative complications did not differ significantly between groups ($P > 0.05$). The overall length of hospital stay was 18.7 ± 6.9 days. Four patients died in hospital (4.8%), and neither hospital stay nor mortality differed significantly between groups ($P > 0.05$) (Table 3).

Table 1: Preoperative characteristics of elderly patients (mean ± SD).

Variable	Overall (n = 124)	On-pump (n = 92)	Off-pump (n = 32)	P value
Age (years)	74.5 ± 7.1	74.9 ± 7.3	73.6 ± 6.8	0.11
Male, n (%)	82 (66.1)	61 (66.3)	21 (65.6)	0.42
BMI (kg/m²)	25.6 ± 3.9	26.1 ± 4.2	24.9 ± 3.5	0.3
Hypertension, n (%)	94 (75.8)	72 (78.3)	22 (68.8)	<0.01
Diabetes mellitus, n (%)	66 (53.2)	49 (53.3)	17 (53.1)	0.24
Stroke, n (%)	30 (24.2)	24 (26.1)	6 (18.8)	<0.01
Previous coronary stenting, n (%)	12 (9.7)	9 (9.8)	3 (9.4)	0.22
Previous myocardial infarction, n (%)	35 (28.2)	26 (28.3)	9 (28.1)	0.18
Renal insufficiency, n (%)	7 (5.6)	5 (5.4)	2 (6.3)	0.72
NYHA class III/IV, n (%)	16 (12.9)	12 (13.0)	4 (12.5)	0.37
Left ventricular ejection fraction (%)	59.1 ± 11.8	58.2 ± 10.2	61.5 ± 12.1	0.25
Three-vessel coronary disease, n (%)	80 (64.5)	72 (78.3)	8 (25.0)	<0.01

Note: BMI, body mass index; NYHA, New York Heart Association.

Table 2: Intraoperative findings in elderly patients undergoing CABG (mean ± SD).

Variable	Overall (n = 124)	On-pump (n = 92)	Off-pump (n = 32)	P value
Number of grafts	3.3 ± 1.3	3.5 ± 1.4	3.2 ± 1.2	0.2
Number of distal anastomoses	3.2 ± 1.2	3.4 ± 1.5	3.1 ± 1.1	0.51
Left internal mammary artery used, n (%)	70 (56.5)	56 (60.9)	14 (43.8)	<0.01
Complete revascularization, n (%)	101 (81.5)	80 (87.0)	21 (65.6)	<0.01
Aortic cross-clamp time (min)	–	67.8 ± 18.1	–	–
Cardiopulmonary bypass time (min)	–	125.9 ± 33.2	–	–
Duration of surgery (h)	4.4 ± 1.5	4.6 ± 1.3	3.9 ± 1.6	0.27

Table 3: Comparison of postoperative outcomes after CABG in elderly patients (mean ± SD).

Variable	Overall (n = 124)	On-pump (n = 92)	Off-pump (n = 32)	P value
Total postoperative drainage (mL)	548.2 ± 74.6	570.3 ± 79.1	526.7 ± 71.5	0.33
Low cardiac output, n (%)	12 (9.7)	9 (9.8)	3 (9.4)	0.34
Perioperative myocardial infarction, n (%)	2 (1.6)	1 (1.1)	1 (3.1)	–
Re-exploration for bleeding, n (%)	5 (4.0)	3 (3.3)	2 (6.3)	0.18
Pulmonary infection, n (%)	19 (15.3)	14 (15.2)	5 (15.6)	0.43
Pleural effusion, n (%)	11 (8.9)	4 (4.3)	7 (21.9)	<0.01
Atrial fibrillation, n (%)	9 (7.3)	5 (5.4)	4 (12.5)	0.29
Mechanical ventilation time (h)	12.3 ± 3.5	13.5 ± 3.6	10.7 ± 3.3	0.61
ICU stay (days)	3.8 ± 1.5	4.1 ± 1.6	2.9 ± 1.4	0.49
Total hospital stay (days)	18.7 ± 6.9	18.2 ± 7.3	19.1 ± 6.8	0.29
In-hospital death, n (%)	6 (4.8)	4 (4.3)	2 (6.3)	0.28

DISCUSSION

CABG remains one of the most effective treatments for coronary heart disease. In clinical practice, it is mainly performed as on-pump CABG or off-pump CABG. However, debate continues regarding which approach offers greater advantages[6-9], particularly in elderly patients with coronary heart disease. The success of CABG depends mainly on graft patency, complete myocardial revascularization, appropriate anesthesia and myocardial protection, effective cardiopulmonary bypass management, close postoperative electrocardiographic and hemodynamic monitoring, and active treatment. Such treatment includes avoiding excessive resistance and volume loading of the heart, reducing myocardial oxygen consumption, and preserving cardiac function. Nevertheless, postoperative complications may still occur, including cardiac tamponade, low cardiac output syndrome, severe arrhythmia, respiratory failure, wound infection, and recurrent myocardial infarction.[10-14] In patients over 70 years of age, major organs commonly show functional decline or limited reserve. Inadequate management may therefore result in relatively high perioperative complication and mortality rates, and postoperative care must be undertaken with particular caution.

In this study, most elderly patients with coronary heart disease had hypertension (75.8%), diabetes mellitus (53.2%), stroke (24.2%), previous myocardial infarction (28.2%), and three-vessel coronary disease (64.5%) before CABG. Hypertension and stroke were more common in patients who underwent on-pump CABG,

with statistically significant differences between groups ($P < 0.05$). In addition, most patients with three-vessel disease underwent on-pump CABG ($P < 0.01$). A history of stroke is a key risk factor for perioperative ischemic stroke in patients undergoing CABG. One possible mechanism is that acute stroke impairs cerebral autoregulation and raises the lower limit of cerebral blood-flow autoregulation. In patients with a history of stroke who undergo CABG, intraoperative blood pressure should therefore not be allowed to fall below the preoperative level, so that cerebral perfusion is maintained. For patients who experienced a stroke within the preceding 6 months, transcranial Doppler ultrasonography or electroencephalographic monitoring should be used to avoid cerebral ischemia and reduce the occurrence of perioperative ischemic stroke.[15-17]

Since Favaloro successfully used the great saphenous vein for an aorta-to-right-coronary-artery bypass graft in 1967, CABG has become internationally recognized as an effective treatment for coronary heart disease.[18] Kurlansky and colleagues proposed that, in patients aged over 70 years, CABG performed using only venous grafts increases perioperative and long-term mortality. Arterial grafts have a 5-year patency rate of more than 90%; therefore, arterial grafts should be used for important diseased vessels, while venous grafts are suitable for diseased vessels at other sites. In particular, lesions of the left coronary artery should be treated using the left internal mammary artery or the left radial artery.[19,20] In the present study, the left internal mammary artery was used as a graft in 56.5% of elderly patients with coronary heart disease, and complete revascularization was achieved in 81.5%, with favorable clinical outcomes. Use of the left internal mammary artery and achievement of complete revascularization were more common in on-pump CABG ($P < 0.01$).

In recent years, off-pump CABG has been widely adopted in China. However, patients aged over 70 years often have multiple comorbidities and relatively complex disease, and the present findings suggest that they may derive greater benefit from on-pump CABG. Although off-pump CABG does not require aortic cannulation or aortic cross-clamping, a side-biting clamp is used on the aortic wall during construction of the proximal anastomosis, and dislodgement of aortic atherosclerotic plaque therefore cannot be completely avoided.[21] During surgery, it is essential to maintain hemodynamic stability, minimize operative time whenever possible, and perform the procedure accurately and gently. Close postoperative monitoring is also particularly important in elderly patients with coronary heart disease.

In this study, complications after CABG in elderly patients included low cardiac output (9.7%), perioperative myocardial infarction (1.6%), re-exploration for bleeding (4.0%), pulmonary infection (15.3%), pleural effusion (8.9%), and atrial fibrillation (7.3%). Pulmonary infection was the most common complication after CABG in this elderly cohort. Intraoperative and postoperative tracheal intubation and the use of anesthetic drugs increase respiratory secretions. Postoperative incisional pain, together with patients' concern that coughing may affect wound healing, may further impair clearance of respiratory secretions and lead to pulmonary infection, atelectasis, and other complications. Respiratory care is therefore a major component of postoperative nursing.[22-24]

The overall length of hospital stay was 18.7 ± 6.9 days and the in-hospital mortality rate was 4.8%; neither differed significantly between the two groups ($P > 0.05$). This study included only 124 patients and therefore has limitations related to its small sample size. A larger sample is needed to more fully characterize the perioperative course of CABG in the overall elderly population.

In conclusion, elderly patients with coronary heart disease undergoing CABG require comprehensive and detailed preoperative evaluation, close intraoperative monitoring of vital signs, maintenance of hemodynamic stability, and early detection and management of complications.

Ethical Statement
This study was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Yangzhou University School of Clinical Medicine prior to the commencement of the study.

Consent for publication
Not applicable.

Data Availability
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest
The authors declare no conflict of interest.

Funding
Not applicable.

Author Contributions
H.A.I.: conceptualization, study design, study proposal, manuscript writing, and submission. H.A.I.: data extraction and data analysis. H.A.I., and W.W..: manuscript revision and formatting. H.A.I., and W.W.: study guidance and final review. All authors have read and agreed to the published version of the manuscript.

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