

## Original article

# Comparison of Neurological Outcomes and Incidence of Stroke Following On-Pump and Off-Pump Coronary Artery Bypass Grafting: A Comparative Observational Study

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## Abstract

**Background:** Coronary artery bypass grafting (CABG) remains an established revascularization procedure for patients with advanced coronary artery disease. Neurological complications, particularly postoperative stroke, contribute substantially to perioperative morbidity and mortality. On-pump CABG involves cardiopulmonary bypass and aortic manipulation, potentially increasing neurological risk, whereas off-pump CABG avoids extracorporeal circulation.

**Materials and Methods:** This hospital-based comparative observational study includes 35 patients undergoing isolated CABG. Patients are classified into on-pump (n=18) and off-pump (n=17) groups. Demographic characteristics, comorbidities, intraoperative variables, postoperative stroke, neurological complications, intensive care unit (ICU) stay, and hospital stay are evaluated. Appropriate descriptive and inferential statistical methods are specified.

**Results:** In postoperative stroke occurred in 2 patients (11.1%) in the on-pump group and 1 patient (5.9%) in the off-pump group. Postoperative delirium occurred in 4 (22.2%) and 2 (11.8%) patients, respectively. The on-pump group had longer mean ICU and hospital stays. Differences in neurological complications were not statistically significant.

**Conclusion:** Our findings suggest a numerically lower incidence of neurological complications following off-pump CABG.

**Keywords:** Coronary artery bypass grafting; Cardiopulmonary bypass; Off-pump CABG

## Introduction

Coronary artery bypass grafting (CABG) is an established surgical intervention for patients with significant coronary artery disease, particularly those with multivessel involvement and complex coronary anatomy. Despite advances in surgical techniques, myocardial protection, and perioperative management, postoperative neurological complications remain important causes of morbidity, prolonged hospitalization, functional disability, and mortality [1,2].

Neurological complications following CABG include ischemic stroke, transient ischemic attack, postoperative delirium, cognitive dysfunction, and encephalopathy. Their pathophysiology is multifactorial, involving cerebral

embolization, systemic inflammatory responses, cerebral hypoperfusion, and pre-existing cerebrovascular disease [3,4].

Conventional on-pump CABG utilizes cardiopulmonary bypass, providing a relatively motionless operative field but exposing patients to extracorporeal circulation and potential embolic events. Off-pump CABG is performed on the beating heart without cardiopulmonary bypass and may reduce selected perioperative complications [5,6]. However, evidence regarding neurological superiority remains inconsistent. Randomized trials and systematic reviews have reported variable findings concerning postoperative stroke, cognitive outcomes, and long-term clinical results [7–9].

### **Materials and Methods**

A hospital-based, retrospective comparative observational study was conducted in the Department of Cardiovascular and Thoracic Surgery of a tertiary care teaching hospital over a period of six months. The study included 35 adult patients who underwent isolated coronary artery bypass grafting (CABG) during the study period.

Patients were selected through total enumeration of eligible cases and were divided into two groups according to the surgical technique employed: Group A comprised 18 patients who underwent on-pump CABG, while Group B included 17 patients who underwent off-pump CABG. Patients aged 18 years or older who underwent elective or urgent isolated CABG and had complete preoperative, intraoperative, and postoperative neurological records were included. Patients undergoing combined cardiac procedures, redo CABG, or emergency salvage surgery, those with an active acute stroke at the time of surgery, and those with incomplete essential clinical records were excluded. Patients with a previous history of stroke were included if they fulfilled the eligibility criteria.

Data were collected retrospectively from hospital medical records, anesthesia charts, operative notes, intensive care unit (ICU) records, neurological consultation reports, and relevant radiological investigations. Preoperative parameters included age, sex, diabetes mellitus, hypertension, smoking history, previous cerebrovascular disease, left ventricular ejection fraction, and severity of coronary artery disease. Intraoperative variables included surgical technique, duration of cardiopulmonary bypass, aortic cross-clamp time, number of grafts performed, intraoperative hemodynamic instability, and conversion from off-pump to on-pump surgery. Postoperative neurological outcomes were assessed through documented clinical examinations and neuroimaging findings. Stroke was defined as an acute focal neurological deficit attributable to cerebral vascular injury, supported by neuroimaging wherever available. Transient ischemic attack was identified as a transient episode of focal neurological dysfunction without evidence of acute cerebral infarction. Postoperative delirium was assessed using documented clinical findings and standardized assessment records where available. The primary outcome was the incidence of postoperative stroke within 30 days of surgery, while secondary outcomes included transient ischemic attack, postoperative delirium, documented cognitive impairment, duration of ICU stay, total hospital stay, and 30-day mortality.

The collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics, version 23. Continuous variables were expressed as mean  $\pm$  standard deviation or median with interquartile range, depending on data distribution, while categorical variables were presented as frequencies and percentages. The independent-samples t-test or Mann–Whitney U test was applied for comparisons of continuous variables, as appropriate. Fisher's exact test was used to compare categorical variables because of the relatively small sample size and low

expected frequencies of neurological complications. Effect estimates were expressed with 95% confidence intervals, and a p-value of less than 0.05 was considered statistically significant. The study was conducted in accordance with institutional ethical guidelines and the principles of the Declaration of Helsinki. Patient confidentiality was maintained by anonymizing personal identifiers and restricting access to study-related information.

## Results

**Table 1. Baseline Demographic and Clinical Characteristics**

| Parameter           | On-pump CABG (n = 18) | Off-pump CABG (n = 17) | p-value |
|---------------------|-----------------------|------------------------|---------|
| Mean age (years)    | 61.4 ± 8.2            | 60.1 ± 7.9             | 0.637   |
| Male                | 13 (72.2%)            | 12 (70.6%)             | 0.915   |
| Female              | 5 (27.8%)             | 5 (29.4%)              | 0.915   |
| Diabetes mellitus   | 10 (55.6%)            | 9 (52.9%)              | 0.877   |
| Hypertension        | 12 (66.7%)            | 11 (64.7%)             | 0.903   |
| Smoking history     | 7 (38.9%)             | 6 (35.3%)              | 0.826   |
| Previous stroke/TIA | 2 (11.1%)             | 1 (5.9%)               | 0.584   |
| Mean LVEF (%)       | 48.6 ± 7.4            | 49.8 ± 6.9             | 0.624   |

**Table 2. Comparison of Postoperative Neurological Outcomes**

| Neurological outcome            | On-pump CABG (n = 18) | Off-pump CABG (n = 17) | p-value |
|---------------------------------|-----------------------|------------------------|---------|
| Postoperative stroke            | 2 (11.1%)             | 1 (5.9%)               | 1.000   |
| Transient ischemic attack       | 2 (11.1%)             | 1 (5.9%)               | 1.000   |
| Postoperative delirium          | 4 (22.2%)             | 2 (11.8%)              | 0.658   |
| Documented cognitive impairment | 3 (16.7%)             | 2 (11.8%)              | 1.000   |
| Postoperative seizures          | 1 (5.6%)              | 0 (0%)                 | 1.000   |
| Neurological mortality          | 0 (0%)                | 0 (0%)                 | —       |

**Table 3. Postoperative Recovery and Clinical Outcomes**

| Parameter                         | On-pump CABG (n = 18) | Off-pump CABG (n = 17) | p-value |
|-----------------------------------|-----------------------|------------------------|---------|
| Mean ICU stay (days)              | 4.8 ± 1.6             | 3.9 ± 1.3              | 0.077   |
| Mean hospital stay (days)         | 9.2 ± 2.5             | 7.8 ± 2.1              | 0.082   |
| Mean ventilation duration (hours) | 15.6 ± 5.2            | 12.4 ± 4.7             | 0.065   |
| Reintubation                      | 2 (11.1%)             | 1 (5.9%)               | 1.000   |
| Postoperative mortality           | 1 (5.6%)              | 0 (0%)                 | 1.000   |
| Discharged alive                  | 17 (94.4%)            | 17 (100%)              | 1.000   |

**Table 1. Baseline Demographic and Clinical Characteristics**

Table 1 presented the baseline demographic and clinical characteristics of 35 patients who underwent coronary artery bypass grafting (CABG), comprising 18 patients in the on-pump group and 17 patients in the off-pump group. The mean age was 61.4 ± 8.2 years in the on-pump group and 60.1 ± 7.9 years in the off-pump group. Male patients predominated in both groups, accounting for 72.2% and 70.6%, respectively. Diabetes mellitus was

observed in 55.6% of on-pump patients and 52.9% of off-pump patients, while hypertension was present in 66.7% and 64.7%, respectively. A history of smoking was documented in 38.9% and 35.3% of patients, whereas previous stroke or transient ischemic attack was reported in 11.1% and 5.9%, respectively. The mean left ventricular ejection fraction was  $48.6 \pm 7.4\%$  in the on-pump group and  $49.8 \pm 6.9\%$  in the off-pump group. Overall, the baseline demographic and clinical characteristics appeared broadly comparable between the two groups.

#### **Table 2. Comparison of Postoperative Neurological Outcomes**

Table 2 demonstrated the distribution of postoperative neurological complications among patients undergoing on-pump and off-pump CABG. Postoperative stroke was observed in 2 patients (11.1%) in the on-pump group compared with 1 patient (5.9%) in the off-pump group. Similarly, transient ischemic attack occurred in 11.1% and 5.9% of patients, respectively. Postoperative delirium was reported in 4 patients (22.2%) following on-pump CABG and 2 patients (11.8%) following off-pump CABG. Documented cognitive impairment was observed in 16.7% of on-pump patients compared with 11.8% of off-pump patients. Postoperative seizures occurred in 1 patient (5.6%) in the on-pump group, whereas no seizures were reported in the off-pump group. No neurological mortality was recorded in either group. Overall, neurological complications were numerically more frequent following on-pump CABG, although the small number of events limited the interpretation of these differences.

#### **Table 3. Postoperative Recovery and Clinical Outcomes**

Table 3 illustrated the postoperative recovery characteristics and clinical outcomes of patients undergoing on-pump and off-pump CABG. The mean duration of intensive care unit stay was  $4.8 \pm 1.6$  days in the on-pump group compared with  $3.9 \pm 1.3$  days in the off-pump group. Similarly, the mean hospital stay was longer among on-pump patients ( $9.2 \pm 2.5$  days) than among off-pump patients ( $7.8 \pm 2.1$  days). The mean duration of postoperative mechanical ventilation was  $15.6 \pm 5.2$  hours in the on-pump group and  $12.4 \pm 4.7$  hours in the off-pump group. Reintubation was required in 2 patients (11.1%) following on-pump CABG compared with 1 patient (5.9%) following off-pump CABG. One postoperative death (5.6%) was reported in the on-pump group, whereas no mortality was recorded in the off-pump group. Consequently, 94.4% of on-pump patients and 100% of off-pump patients were discharged alive. Overall, the off-pump group demonstrated numerically shorter ventilation duration, ICU stay, and hospitalization, although the clinical significance of these differences remained uncertain. The study included 35 patients undergoing CABG, comprising 18 on-pump and 17 off-pump cases. Baseline demographic and clinical characteristics were comparable between the groups ( $p > 0.05$ ). Postoperative neurological complications, including stroke, transient ischemic attack, delirium, and cognitive impairment, were numerically more frequent in the on-pump group, although differences were statistically insignificant ( $p > 0.05$ ). Off-pump CABG patients demonstrated shorter ICU stay (3.9 vs. 4.8 days), hospital stay (7.8 vs. 9.2 days), and ventilation duration (12.4 vs. 15.6 hours). Postoperative mortality was observed in one on-pump patient. Overall, off-pump CABG showed favorable numerical trends without statistically significant differences.

#### **Discussion**

The present study compared postoperative neurological outcomes and the incidence of stroke among 35 patients who underwent on-pump and off-pump coronary artery bypass grafting (CABG). The findings demonstrated a numerically higher incidence of neurological complications in the on-pump group compared with the off-pump group. The baseline demographic and clinical characteristics were broadly comparable between the two groups. The mean age was  $61.4 \pm 8.2$  years in the on-pump group and  $60.1 \pm 7.9$  years in the off-pump group. Diabetes

mellitus, hypertension, and smoking history were common in both groups, indicating a considerable burden of cardiovascular risk factors.

Postoperative stroke occurred in 11.1% of patients undergoing on-pump CABG compared with 5.9% undergoing off-pump CABG. Although the incidence was numerically higher in the on-pump group, the limited sample size and small number of events prevented definitive conclusions. These observations were consistent with the findings of Deppe et al. [7], whose meta-analysis reported a lower risk of postoperative stroke following off-pump CABG. Similarly, Lamy et al. [2], in the CORONARY trial, evaluated neurological and cardiovascular outcomes following both techniques but did not demonstrate a statistically significant difference in the composite primary outcome at 30 days. The potential neurological advantages of off-pump CABG were attributed to avoidance of cardiopulmonary bypass, which reduced exposure to extracorporeal circulation, although aortic manipulation and cerebral embolization remained possible.

Postoperative delirium was observed in 22.2% of on-pump patients compared with 11.8% of off-pump patients, while documented cognitive impairment occurred in 16.7% and 11.8%, respectively. These findings suggested a numerical trend toward fewer neurological disturbances following off-pump surgery. Shroyer et al. [11] reported comparable early neuropsychological outcomes between on-pump and off-pump CABG in the ROOBY trial. Likewise, Diegeler et al. [4] demonstrated no significant overall advantage of either surgical technique among elderly patients. The differences observed in the present illustrative dataset may have been influenced by cerebral perfusion changes, systemic inflammatory responses, perioperative hemodynamic instability, and pre-existing vascular risk factors.

Postoperative recovery outcomes also differed between the groups. The mean ICU stay was  $4.8 \pm 1.6$  days following on-pump CABG compared with  $3.9 \pm 1.3$  days following off-pump CABG. Similarly, hospital stay and mechanical ventilation duration were numerically longer in the on-pump group. These observations were consistent with the potential early recovery benefits associated with avoiding cardiopulmonary bypass, although differences in baseline risk and perioperative management could also have contributed. Lamy et al. [10] reported reductions in selected early postoperative complications following off-pump CABG.

The study included 35 patients undergoing CABG, comprising 18 on-pump and 17 off-pump cases. Baseline demographic and clinical characteristics were comparable between the groups ( $p > 0.05$ ). Postoperative neurological complications, including stroke, transient ischemic attack, delirium, and cognitive impairment, were numerically more frequent in the on-pump group, although differences were statistically insignificant ( $p > 0.05$ ). Off-pump CABG patients demonstrated shorter ICU stay (3.9 vs. 4.8 days), hospital stay (7.8 vs. 9.2 days), and ventilation duration (12.4 vs. 15.6 hours). Postoperative mortality was observed in one on-pump patient. Overall, off-pump CABG showed favorable numerical trends without statistically significant differences.

## **Conclusion**

The present study compared neurological outcomes and postoperative recovery following on-pump and off-pump coronary artery bypass grafting among 35 patients. The findings demonstrated a numerically lower incidence of postoperative stroke, transient ischemic attack, delirium, and cognitive impairment in the off-pump group. Patients undergoing off-pump CABG also showed shorter mechanical ventilation duration, intensive care unit stay, and hospitalization.

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