



Comparison of on-pump versus off-pump coronary artery bypass surgery in diabetic patients

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ABSTRACT:

Background: The coronary artery disease was very common among diabetic patients and was also a contributor to the higher morbidity and mortality rates after the coronary artery bypass grafting (CABG). Abreast surgery to this at-risk group was controversial as to the best surgical method. On-pump CABG which was done using cardiopulmonary bypass was historically believed to be the optimal modality but off-pump CABG continued to be more popular as a method of reduction of systemic inflammatory response, metabolic derangements and end-organ complications especially in diabetic patients who were prone to the negative effects in a more pronounced manner.

Aim: This study was meant to compare the perioperative and the early postoperative results of on-pump and off-pump coronary artery bypass surgery in diabetic patients.

Methods: The comparative study was done in Shifa International Hospital Islamabad, between November 2024 and October 2025. One hundred and ten diabetic patients who had undergone isolated CABG were enlisted in the research. The patients were split into two categories, depending on the method of surgery performed: on-pump CABG group and off-pump CABG group. Demographic information, comorbidity, and operation characteristics were taken at baseline. Outcomes measured in the postoperative period were duration of mechanical ventilation, length of stay in the intensive care unit (ICU), total length stay, occurrence of postoperative complications which included; atrial fibrillation, wound infection, renal dysfunction and in-hospital mortality. Proper statistical tools were used to conduct data analysis with an aim of comparing the results of the two groups.

Results: The off-pump CABG group had a much short mechanical ventilation and less ICU/ hospital stay than the on-pump group. The incidence of postoperative complications such as atrial fibrillation, kidney dysfunction and infection on the surgical site was lower among patients who had off-pump CABG. In-hospital mortality also showed a decrease in the off-pump; this was not statistically significant. Comprehensively, off-pump CABG was linked to lower economic postoperative results in diabetic patients.

Conclusion: Off-pump coronary artery surgery was found to have lower postoperative morbidity and recognition of a shorter recovery time than on-pump CABG did with diabetic patients. They were pointing towards the belief that off-pump CABG was a safe and efficient alternative to the standard on-pump method in this high-risk group, especially in those areas that minimize early postoperative complications.

Keywords: Coronary artery bypass grafting, On-pump CABG, Off-pump CABG, Diabetes mellitus, Postoperative outcomes.



INTRODUCTION:

Coronary artery disease (CAD) had been among the most prevalent causes of morbidity and mortality globally with it being noted that the disease has a rather high prevalence in patients with diabetes mellitus. Diabetes was considered as a significant independent risk factor leading to the onset of CAD and its progression because of its links to endothelial dysfunction, a speedier atherosclerosis, chronic inflammation, and metabolic imbalances [1]. Patients with diabetes regularly developed diffuse and multivessel coronary involvement and smaller-caliber vessels, complicating and difficult revascularization plans. Consequently, the common belief among the community was that, coronary artery bypass grafting (CABG) was the ideal form of revascularization in diabetic patients, which had better long-term results than percutaneous coronary intervention to the high-risk group [2].

The traditional CABG was conventionally done through cardiopulmonary bypass which is generally known as on-pump CABG. The procedure in this case was the arrestation of the heart and the diversion of blood flow in an extracorporeal circuit, which allowed a still and blood-free operating field to be sufficed with a high level of exact anastomosis. On-pump CABG had proven to have good graft patency and long-run survival outcomes but was nonetheless shown to have a number of side effects [3]. Systemic inflammatory response, oxidative stress, coagulation abnormalities and end-organ dysfunction was associated with the use of cardiopulmonary bypass. These complications especially postoperative infections, renal dysfunction, neurocognitive deficit, and extended time in hospital have been especially vulnerable to diabetic patients due to their impaired immune response and microvascular disease [4].

Trying to stay to a minimum the complications of the cardiopulmonary bypass, off-pump coronary artery bypass surgery (OPCAB) was introduced and was gaining more and more popularity. Off-pump CABG was already done using a beating heart without the need to use extracorporeal circulation as special stabilization devices enabling the generation of coronary anastomosis [5]. This methodology had been suggested to diminish inflammatory process, perioperative blood loss and organ complications. These possible benefits were of particular interest to diabetic patients since the perioperative outcomes could be positively correlated with a lower degree of surgical stress and the maintenance of physiological homeostasis [6].

The off-pump CABG technique, though theoretically superior, had been debated with regard to clinical superiority over the on-pump method. Multiple studies had documented decreasing morbidity in the early years with off-pump CABG such as decrease in the atrial fibrillation rate, renal management and wound infections. On the other hand, there had been raised concerns about technical complexity of off-pump procedures, incomplete revascularization, reduced number of distal anastomoses and even poor long-term graft patency [7]. These concerns had been specially relevant among diabetic patients where a complete and long-lasting revascularization was frequently needed secondary to diffuse coronary disease.

In addition, the available literature had demonstrated contradictory findings on comparing on-pump versus off-pump CABG among diabetic groups only. Though a few studies were already proposing better short-term outcomes with off-pump surgery, there are studies which had not detected any significant difference or rather preferred on-pump CABG



with regard to completeness of revascularization and long-term survival [8]. Differences in surgical skill, patient selection, institutional policies and outcome measures had been contributing factors to these discrepancies and emphasized the need to have additional focused appraisal. Since diabetes is increasing and had a strong correlation with unfavorable cardiovascular outcomes, it was of utmost importance to optimize surgical revascularization in the subgroup. To enable clinicians to make an effective clinical decision and enhance patient outcome, a clear insight of the relative advantages and drawbacks of on-pump versus off-pump CABG in diabetic patients had been necessary [9]. Hence, the current research had been a comparative study between on-pump and off-pump surgery on the coronary artery bypass surgery in diabetic patients, and the purpose of the study was to assess the result of the surgery peri-operative outcomes, post-operative complications, and the overall performance of each of the two methods [10].

MATERIALS AND METHODS:

This research was carried out in Shifa international hospital (Islamabad) between November 2024 and October 2025. The purpose of the study was to compare the patients undergoing on-pump and off-pump coronary artery bypass grafting (CABG) to determine their results in diabetic patients. The sample size used in the study was 110 diabetic patients who underwent elective CABG. The Institutional Review Board of Shifa International Hospital approved the ethical process before the study started, and all the participants signed a written informed consent.

The study design adopted was descriptive, comparative, and observational study. The patients were separated into two categories depending on the nature of surgery. Group A consisted of patients undergoing on-pump CABG

with cardiopulmonary bypass (CPB) whereas Group B consisted of patients undergoing off-pump CABG without cardiopulmonary bypass (CPB). The assignment to either group was mainly done at discretion of the operating surgeon factoring in patient-specific factors, coronary anatomy, as well as comorbid conditions.

The inclusion criteria included adult patients aged between 40-75 years of age, and confirmed with diabetes mellitus type 2 and required isolated CABG due to multivessel coronary artery disease. Patients undergoing cardiac surgery experiences before, having valve surgery, as well as that experience serious left ventricle dysfunction (ejection fraction is less than 30 percent), severe renal or hepatic dysfunction were excluded. To ensure homogeneity, patients with acute coronary syndrome and who needed emergency surgery were locked out too.

Preoperative check-up was a detailed history taking, physical examination, laboratory check-ups such as fasting blood sugar, HbA1c, renal tests, liver tests, and echocardiography to sense the heart functionality. All patients underwent the coronary angiography in order to evaluate the occurrence and degree of the coronary artery disease. Baseline demographic and clinical information, age, gender, duration of diabetes, comorbidities, and preoperative medication were noted down.

Surgery was done according to the best operating procedures. Systemic heparinization with CABG on-pump followed by commencement of CPB, aortic cross-clamping and cold cardioplegia myocardial protection. In the case of off-pump CABG, the target coronary vessels were immobilized by means of enabling hemodynamic stability with the help of stabilization devices. Graft type and number used in the graft, blood loss intraoperative,



operation time and the intraoperative complications were recorded.

Monitoring was the postoperative treatment at cardiac intensive care. The hemodynamic parameters, requirement of inotropes, mechanical ventilation, atrial fibrillation, myocardial infarction, renal dysfunction, wound infections, cerebrovascular events, and other complications were included into data that was collected. Length hospital stay and 30-day mortality were also taken. Glycemic control ensured as per the hospital protocol and the insulin therapy modified in terms of serial blood glucose.

The SPSS software version 26 was used to do statistical analysis. Mean and standard deviation were used to define continuous variables and the independent t-test was used to compare the variables. Categorical variables were at frequencies in percentages and compared them through chi-square test or Fisher test where necessary. The statistical value of any less than 0.05 was considered significant.

This approach replicated a methodological approach that guaranteed a comparative analysis of on and off-pump CABG in diabetic patients in terms of intraoperative, postoperative, and short-term clinical outcomes.

RESULTS:

Eleven participants of the study were diabetic patients who used coronary artery bypass grafting (CABG) in Shifa International Hospital at Islamabad between November 2024 and October 2025. Out of these 55 patients received on-pump CABG and 55 patients received off-pump CABG. Demographic factors (age, distribution of genders and comorbidities) were similar in both groups ($p > 0.05$), which provided some balance upon which the comparison would be conducted.

Table 1: Perioperative Outcomes in On-Pump vs Off-Pump CABG:

Parameter	On-Pump CABG (n=55)	Off-Pump CABG (n=55)	p-value
Mean operative time (minutes)	210 ± 25	185 ± 20	<0.001
Mean aortic cross-clamp time (min)	85 ± 15	N/A	-
Mean number of grafts per patient	3.2 ± 0.8	2.9 ± 0.7	0.042
Intraoperative blood loss (ml)	750 ± 120	480 ± 100	<0.001
Need for intraoperative transfusion	30 (54.5%)	15 (27.3%)	0.004

Table 1 showed that on-pump CABG patients experienced operations that were much longer, and had an increased intraoperative blood loss than off-pump CABG patients. Only on-pump surgeries could be considered when the aortic cross-clamp time was used. There was also a higher number of intraoperative blood transfusion in the on-pump group that was statistically significant ($p = 0.004$). The average graft count was a little more in the on-pump group and this showed an intensive way of revascularization, yet the clinical significance was average.

Table 2: Postoperative Outcomes and Complications in On-Pump vs Off-Pump CABG

Parameter	On-Pump CABG (n=55)	Off-Pump CABG (n=55)	p-value
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ICU stay (hours)	48 ± 10	36 ± 8	<0.001
Hospital stay (days)	9 ± 2	7 ± 1.5	<0.001
Postoperative atrial fibrillation	15 (27.3%)	7 (12.7%)	0.045
Postoperative myocardial infarction	3 (5.5%)	2 (3.6%)	0.645
Wound infection	4 (7.3%)	3 (5.5%)	0.699
30-day mortality	2 (3.6%)	1 (1.8%)	0.556

Table 2 demonstrated that off-pump CABG patients stayed longer in the ICU and in the hospital in general giving the impression that the recovery process was faster. Postoperative atrial fibrillation was much more frequent in the on-pump group ($p = 0.045$) and there was no significant difference in major adverse events between the two groups ($p > 0.05$), showing likes of postoperative myocardial infarction, wound infection, and 30 days mortality.

All in all, the results have demonstrated that off-pump CABG surgery among diabetic patients regarding shorter operation time, less intraoperative bleeding, less transfusion, shorter ICU stay, and shorter hospital stay and fewer rates of postoperative atrial fibrillation. Conversely, the on-pump and off-pump procedures were equally effective in graft number, major cardiac complications, and short time mortality. These findings indicated that off-pump CABG may be perioperative advantageous especially in diabetic patients who were susceptible to post-operative complications.

DISCUSSION:

The current paper compared the clinical performances between on-pump and off-pump coronary artery bypass grafting (CABG) in diabetics and also put into perspective

significant differences in perioperative and early postoperative outcomes between the two methods. Diabetes mellitus is being confirmed as one of the most serious risk factors that can affect morbidity and mortality after cardiac surgery partially because the disease is associated with diffuse coronary artery disease, endothelial dysfunction, delayed wound healing, and increased inflammatory responses [11]. Thus, it was still clinically relevant to find the best surgical approach to this high-risk population.

In this article, off-pump CABG was identified to have more favorable perioperative profile over on-pump CABG. The patients that underwent off-pump surgery had reported short operative times, less blood loss so far as the intraoperative level is concerned, and less blood transfusion. The results were in line with the hypothesis that evasion of cardiopulmonary bypass in the best interest of the avoidance of hemodilution and coagulation disturbances that are especially harmful in diabetic patients [12]. Clinical significance of the lower levels of transfusion in the off-pump group were due to the fact that transfusion has been known to result in higher infection rates and poor cardiovascular outcomes in diabetics.

The results of postoperative suggested the possible superiority of the off-pump technique further. The postoperative complications such as atrial fibrillation, renal dysfunction, and extended ventilation by machines were reduced in the off-pump group. These results indicated that the removal of cardiopulmonary bypass inhibited the process of systemic inflammatory response and oxidative stress which are magnified in diabetic individuals because of the systematic abnormalities in metabolism and vasculature [13]. Renal protection was especially applicable since diabetic patients are highly susceptible to perioperative renal dysfunction



and the prevention of non-pulsatile flow and inflammatory mediators could have led to an improved renal outcome.

The occurrence of wound-related complications and the occurrence of infections were also less in patients undergoing off-pump CABG. The presence of diabetes is known to mediate the impairment of immune functioning and wound healing, which is why the incidence of sternal wound infection is a major issue [14]. This might have been due to the decreased trauma during the operation at the off-pump category, fewer transfusion, and the increased conservation of tissue perfusion which may have led to less infection in the off-pump. These results were consistent with the existing literature that indicated less infectious complications with off-pump procedures in high-risk patients.

Nevertheless, there were some strengths that should be mentioned in the on-pump CABG group. Total revascularization was more steadfast among the on-pump population, especially in patients who had complicated or diffuse coronary artery disease [15]. Cardiopulmonary bypass allowed surgery to be carried out on a stable, bloodless field, allowing multiple distal anastomoses to be carried out with much technical convenience. This was particularly crucial in diabetic patients which regularly manifest with multi vessel disease. Despite an earlier morbidity, it was still questioned whether off-pump surgery was long term completeness and durability of revascularization.

This study did not find any significant difference in mortality between the two groups indicating that the two techniques were safe when carried out by well trained surgical teams. This was in line with the literature that showed similar short-term survival rates of on-pump and off-pump CABG. Lack of mortality difference underscored the fact that patient selection,

expertise of the surgeon and perioperative care were important factors in improving outcomes and not the surgical technique alone.

This research had limitations though it had its advantages. The findings might have been generalized with limited or no consideration given to the fact that the sample size was relatively small and the study was conducted in one center only. Only long-term outcomes like graft patency and late survival were not measured and thus could not be compared between the two methods. Also, the experience of the surgeon with off-pump CABG might also have affected the outcomes, which led to the possibility of bias in the performance.

Concisely, the results indicated that off-pump CABG had significant short-term benefits in diabetic patients as it minimized the post operative complications and the perioperative morbidity, whereas on-pump CABG provided more complete revascularization in advanced cases. The personalized approach that considers the risk profile of the patient and coronary anatomy was considered crucial in the choice of the best surgical mode to use in the procedure of the diabetic patients undergoing CABG.

CONCLUSION:

This research found that on-pump and off-pump coronary artery bypass grafting was an effective operation method that gave satisfactory clinical results in diabetic patients with coronary artery diseases and both had acceptable clinical outcomes. A reduced rate of early postoperative complication, such as less blood transfusion, a decreased period of mechanical ventilation, and a reduced length of hospital stay, was found to be associated with off-pump CABG. Contrarily, on-pump CABG offered a superior volume of revascularization and was linked to steady intraoperative hemodynamics, especially in those with a complex multivessel disease. The total perioperative mortality was not



significantly different in the two groups. The results indicated that the selection of the patient was very important in deciding on the best way of doing surgery. It was found that off-pump CABG was beneficial among the diabetic patients who have increased risks of pump complications whereas on-pump CABG was beneficial in anatomically inexperienced cases. These findings were conducive to the individualized and patient centered approach in selecting the approach of operating a patient to a surgery that involved coronary artery bypasses in diabetic patients.

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