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Original Article

Off versus On pump coronary artery bypass grafting; a single-center experience

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Abstract

Background: The debate about on-pump vs. off-pump coronary artery bypass grafting (CABG) continues. The present study compared the short-term outcomes after off-pump vs. on-pump CABG.

Methods: The study was conducted on 67 patients who underwent CABG from 2021 to 2022. Patients were divided into two groups according to the CABG technique. Group 1 included 33 patients who underwent off-pump CABG, and Group 2 included 34 patients who underwent on-pump CABG. The study outcomes were operative time, hospital complications, and mortality.

Results: On-pump patients were significantly older than off-pump patients (64.78±7.12 vs. 59.09±6.29; p= 0.004). There were no differences in comorbidities, presenting symptoms, or ejection fraction between groups. Operative time was significantly shorter in off-pump patients (227.47±13.73 vs. 321.12±27.49; p< 0.001). Blood transfusion was lower in off-pump patients (1.06± 0.311 vs. 1.79± 0.25; p< 0.001). Bleeding was lower in off-pump patients (0.81±0.13 vs. 0.91±0.20 ml, p= 0.01). Off-pump patients had significantly shorter ICU (3.5±2.6 vs. 4.9±4.7; p<0.001) and hospital stay (7.6±4.8 vs. 9.5±6.1; p<0.001). No patient had re-exploration for bleeding, wound infection, or mortality in our series. One patient had renal impairment in the on-pump group (p>0.99).

Conclusion: Off-pump and on-pump CABG seem to be safe approaches for managing coronary artery disease in our institution. Off-pump could be superior to on-pump CABG regarding shorter ICU and hospital stay. Studies with data from a large number of patients are recommended.

KEYWORDS
Coronary artery bypass grafting; On-pump; Off-pump; Cardiopulmonary bypass

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Introduction

Coronary artery bypass grafting (CABG) remains the most common worldwide cardiac surgery procedure [1]. Off-pump CABG is not a new concept, and its origin dates back to the introduction of the CABG technique [2, 3]. Off-pump CABG has several proposed advantages because of avoiding the use of cardiopulmonary

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bypass (CPB) and aortic cross-clamp [4, 5]. On-pump CABG is the traditional approach; however, the inflammatory response resulting from cardiopulmonary bypass may lead to renal dysfunction, and aortic cross-clamp could lead to increased stroke risk. Reducing complication rates with off-pump CABG could be associated with reduced operative costs [6]. Off-pump CABG is technically demanding; the outcomes depend on the surgeons' experience and could be associated with incomplete revascularization [4, 5]. The study aimed to compare the early outcomes of off-pump vs. off-pump CABG.

Patients and Methods

Patients and design

The present study is a prospective cohort study that included 67 patients. The patients were grouped into two groups; Group 1 included 33 patients with off-pump CABG, and Group 2 included 34 patients with on-pump CABG. All patients were admitted between January 2021 and December 2022. The study included patients undergoing primary and isolated CABG whose ages ranged between 20 and 80 years. Patients who had concomitant cardiac procedures, end-organ failure, recent myocardial infarction (< 6 weeks), previous cardiac surgery, and carotid stenosis (>50%) were excluded. Patients who refused to sign an informed consent were also excluded.

The study design complied with the declaration of Helsinki, and the Ethical Committee approved the conduction of the study (IRB No: 17300944). All patients had signed informed consent before the procedure.

Techniques:

All patients underwent a standard anesthesia induction protocol, and a pulse oximeter, 5-lead ECG, and blood pressure lines were connected. Patients were pre-oxygenated with 100% oxygen before induction. Anesthesia was induced with propofol in a dose of 2 to 2.5 mg/kg intravenously (IV) titrated at approximately 40 mg every 10 seconds; additionally, 5 µg/kg fentanyl and either 0.5 mg/kg atracurium or 0.2 mg/kg cisatracurium were given. Anesthesia was maintained with sevoflurane which was switched to 1.2% isoflurane, with an infusion of fentanyl 1 mg/kg/hour and the same muscle relaxant used in induction. Controlled mechanical ventilation with 50% FiO2 was used. In case of heart rate (HR)< 45/min, atropine was given; for systolic blood pressure (SBP) < 80 mmHg, ephedrine, adrenaline, or dopamine was used. For HR > 100/min, esmolol was used.

All surgical procedures were performed through median sternotomy in both groups. The left internal mammary (LIMA) was grafted to the anterior descending in all patients. A full heparin dose was used in patients who underwent on-pump CABG and a half dose in off-pump patients. Proximal anastomoses were done on the beating heart after removing the aortic cross-clamp in the on-pump group. The surgeons did not use any coronary shunt at any point of off-pump CABG. Hemostasis and chest closure were performed using the same technique in both groups.

Study data:

Preoperative data included age, gender, diabetes mellitus, hypertension, smoking, elevated troponin, and ejection fraction (EF). The extent of coronary artery disease in the preoperative coronary angiography was reported. Intraoperative data included operative time, bleeding, and arrhythmia. Postoperative outcomes included the duration of ICU and hospital stay, wound infection, renal impairment, and hospital mortality.

Statistical analysis

SPSS version 22 (IBM Corp- Chicago- IL) was used for analysis. Mean, and standard deviation was used to present parametric data, which were compared by independent t-test or Mann-Whitney test. The chi-squared or Fisher exact test was used to compare quantitative data. A P-value < 0.05 was considered significant.

Results

Preoperative data

Age was significantly higher in patients with on-pump CABG than in off-pump patients (p= 0.004). There were no differences in comorbidities, presenting symptoms, or ejection fraction between groups. The extent of coronary

Table 1: Comparison of the preoperative demographic and clinical data of patients who had on-pump vs. off-pump coronary artery bypass grafting

Parameter	Off-pump (n=33)	On-pump (n=34)	p-value
Age (years) (mean±SD)	59.09±6.29	64.78±7.12	0.004
Males, n (%)	28 (85%)	29 (85%)	0.96
Comorbidities: n (%)			
Diabetes Mellitus	1 (3%)	2 (6%)	>0.99
Hypertension	8 (24%)	7 (21%)	0.78
Diabetes and hypertension	16 (48%)	22 (65%)	0.22
Smoking	0	3 (9%)	0.24
Complaint: n (%)			
Chest Pain	31 (94%)	32 (94%)	>0.99
Chest pain and dyspnea grade II	2 (6%)	2 (6%)	>0.99
Positive troponin, n (%)	4 (12%)	8 (24%)	0.34
Ejection fraction (%) (mean± SD)	59.69± 6.86	61.32±10.8	0.26
Coronary artery disease, n (%)			
One-vessel	1 (3%)	0	
Two-vessel disease	7 (21%)	8 (23.5%)	>0.99
Three-vessel disease	25 (76%)	26 (76%)	

artery disease did not differ between groups. (Table 1)

Four patients had a mild rise in liver enzymes, one had a moderate rise in renal function test, and one had hypoalbuminemia in the off-pump group. Four patients had a mild increase of liver enzymes, one had asthma, one had hypothyroidism, and one had reflux esophagitis in the on-pump group.

Operative data:

Operative time was significantly shorter in off-pump patients (227.47± 13.73 vs. 321.12± 27.49; p< 0.001). Blood transfusion was lower in off-pump patients (1.06± 0.311 vs. 1.79± 0.25; p< 0.001). Bleeding was lower in off-pump patients (0.81± 0.13 vs. 0.91± 0.20 ml, p= 0.01). Two patients in the off-pump group were converted to on-pump. (Table 2)

Postoperative outcomes:

Off-pump patients had significantly shorter ICU (3.5±2.6 vs. 4.9±4.7; p<0.001) and hospital stay (7.6±4.8 vs. 9.5±6.1; p<0.001). No patient had reexploration for bleeding, wound infection, or mortality in our series. One patient had renal impairment in the on-pump group (p>0.99). (Table 3)

Discussion

Coronary artery bypass graft surgery can be performed with and without cardiopulmonary bypass. Our local experience revealed that off-pump was associated with an increased need for blood transfusion and bleeding. Moreover, the need for IABP was lower in the off-pump patients than in the on-pump group. In addition, the present study resulted in shorter ICU and hospital stay duration, and the operative time was longer in on-pump patients.

Table 2: Comparison of the operative data of patients who had on-pump vs. off-pump coronary artery bypass grafting

Parameter	Off-pump (n= 33)	On-pump (n= 34)	p-value
Operative time (minutes) (mean±SD)	227.47±13.73	321.12±27.49	<0.001
Blood transfusion (liter) (mean±SD)	1.06± 0.311	1.79± 0.25	<0.001
Bleeding (liter) (mean±SD)	0.81±0.13	0.91±0.20	0.01
Conversion to on-pump, n (%)	2 (6.06%)	NA	
Ventricular tachycardia, n (%)	2 (6.06%)	6 (17.65%)	0.259
Intra-aortic balloon pump, n (%)	2 (6.06%)	6 (17.65%)	0.259

Table 3: Comparison of the postoperative data of patients who had on-pump vs. off-pump coronary artery bypass grafting

Parameter	Off-pump (n= 33)	On-pump (n= 34)	p-value
ICU stay (days) (means± SD)	3.5±2.6	4.9±4.7	<0.001
Renal affection, n (%)	0	1 (3%)	>0.99
Hospital Stay(days) (mean± SD)	7.6±4.8	9.5±6.1	<0.001
Hospital Mortality, n (%)	0	0	

ICU: intensive care unit

Sharony and colleagues [7, 8] reported that the off-pump group was associated with fewer incidences of stroke and mortality compared to the on-pump group. Moreover, the authors found improved survival in the off-pump group after three years of follow-up. Hirose and colleagues [9] mentioned that bleeding, transfusion, stroke, prolonged ICU, and hospital stay were higher in the on-pump group. On the other hand, myocardial infarction, renal failure, and wound infection showed no significant differences between the two surgical groups. These previous studies go hand in hand with our results.

Locker [10] and Islam and their colleagues [11] summarized the advantage of on-pump CABG as being familiar to most surgeons, better in emergencies, and more complete vascularization with more distal anastomosis. However, they reported that off-pump was accompanied by less inflammatory cytokines, fewer cerebral emboli, less morbidity, and mortality, and was a suitable option for older patients. Shroyer and associates [12] reported operative time in on-pump and off-pump 4.4±1.4 hours and 4.5±1.4 hours, respectively. The authors stated that the operative time off-pump surgery depends on the surgeons' experience. Moreover, Husain et al. [13] reported a significant increase in inotropes given to on-pump patients compared to off-pump patients. The authors added that this may be due to hypotension and arrhythmia following cardioplegia to improve heart contractility. However, Bakaeen et al. [14] reported that the number of grafts used in off-pump was significantly less than in on-pump surgery. Abdo et al. [15] reported that revascularization in the off-pump was significantly better than in the on-pump survey group. Hussain [13] and Tastushini and their collaborators [16] reported that ventilation time was significantly lower in the off-pump surgery than in the on-pump surgery. From the previous data, our results more or less go with the previous recorded studies. However, we need more data regarding the two types of surgery with longer follow-up duration to have a palatable conclusion.

Study limitations

The study has several limitations, including the single-center experience, the small number of patients, and the limited follow-up period. However, the study presents our initial experience and studies with longer follow-up are recommended.

Conclusion

Off-pump and on-pump CABG seem to be safe approaches for managing coronary artery disease in our institution. Off-pump could be superior to on-pump CABG regarding shorter ICU and hospital stay. Studies with data from a large number of patients are recommended.

Conflict of interest: Authors declare no conflict of interest.

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