On Pump versus Off-Pump CABG in early-Stage renal impairment

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Abstract

Background: One of the most reliable methods of revascularization for individuals with coronary artery disease (CAD) is coronary artery bypass grafting (CABG) surgery. **The aim of this work**: was to examine the early outcomes (during the hospital stay) of an isolated CABG in patients who had mild to moderate preoperative blood creatinine elevations (1.6 to 2.5 mg/dl) (whose GFR ranges from 60 to 89).

Patients and methods: 60 patients with ischemic heart disease who were scheduled for myocardial revascularization at Kasr El Aini and had preoperative blood creatinine levels between 1.6 and 2.5 mg/dl were included in this prospective, non-randomized trial (Whose GFR ranges from 60 to 89).

Results: The difference in postoperative creatinine levels between the off-pump group and the on-pump group is statistically significant, demonstrating the role of CPB in this phenomenon.

Conclusion: Analysis of the postoperative outcomes revealed no connection between postoperative renal impairment and findings in the abdomio-pelvic ultrasound. All patients should use general precautions to avoid renal dysfunction after cardiac surgery, paying particular attention to those who already have preoperative renal impairment. A effective treatment will ultimately include tactics that focus on these many channels. This multifaceted approach would focus on inflammatory, oxidative, and hemodynamic pathways, acting close to the sites of cellular harm.

Keywords: On Pump; Off Pump; CABG; early stage renal impairment.
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Introduction

Coronary artery bypass grafting (CABG) surgery is one of the most efficient ways of revascularization for patients with coronary artery disease (CAD). Historically, cardiopulmonary bypass and a halted heart were employed to perform coronary artery bypass surgery. Due to the invention of cardiac stabilisers, it is now possible to do surgery on a beating heart, therefore avoiding cardiac arrest and cardiopulmonary bypass. By avoiding cardiac arrest and cardiopulmonary bypass, it was believed that coronary artery bypass surgical complications may be mitigated (1).

Regarding stroke, myocardial infarction, renal insufficiency, atrial fibrillation, and coronary reintervention, there was no definitive evidence of benefit or harm. When conducted on a beating heart, cardiac arrest and cardiopulmonary bypass seem less hazardous than coronary artery bypass surgery. Coronary artery bypass procedures on a beating heart may be an alternative for patients with contraindications to cannulation of the aorta and cardiopulmonary bypass; nevertheless, randomised clinical trials are necessary to establish the most beneficial technique for these patients.

The off-pump coronary artery bypass grafting (CABG) procedure was developed in the middle of the 1990s with the goal of reducing the postoperative morbidity and mortality associated with cardiopulmonary bypass. Some of these complications include a systemic inflammatory response, global myocardial ischemia, renal failure, neurologic complications, and hemodynamic instability.

In high-risk patients, OPCAB may reduce operational mortality and postoperative morbidity compared to on-pump CABG, even if a single-center randomized controlled trial did not demonstrate a difference between the two treatments (2).

CPB-related events, including hypotension, hypoperfusion, loss of pulsatility, hemolysis, and release of proinflammatory chemicals, may considerably contribute to this condition, despite the fact that the etiology is multifaceted and dependent on the patient's clinical situation, age, type I diabetes, recent exposure to nephrotoxic drugs, etc (3). Additionally, the length of CPB has a significant detrimental impact on changes in renal function integrity (4).

Many of the off-pump technique's technical challenges have been solved thanks to the invention of tools like stabilizers, snares, shunts, and suction cones by a quick-thinking industry. Today, anastomoses may be performed on practically all heart areas with varying degrees of comfort and safety. Numerous research has backed up the acceptable short-term patency rates (5).

Patientsandmethods

This prospective, non-randomized research comprised 60 patients with ischemic heart disease who were candidates for myocardial revascularization at Kasr El Aini and whose preoperative blood creatinine levels ranged from 1.6 to 2.5 mg/dL. (Whose GFR ranges from 60 to 89).

Patients were divided into two groups: Gropu (A): 30 individuals receiving isolated on-pump surgery. Group (B): Thirty patients receiving surgery off-pump (Beating Heart).

InclusionCriteria: Anypatientsubmitted toisolateelectiveCABG:A)and B):1-IsolatedMulti-vesselcoronaryarterydisease.2-Ejection fraction more than 50

ExclusionCriteria: Patients with the following conditions: normal serum creatinine levels, emergent surgery, single-vessel disease, , left ventricular ejection fraction 50 percent, intended OPCAB but reverted to pump due to hemodynamic instability, redo CABG, combined cardiac surgery, and uncontrolled diabetes.

This study aims to evaluate the early outcomes (during hospitalisation) of isolated CABG performed on-pump vs off-pump in patients with preoperative mild to moderate blood creatinine increase (1.6 to 2.5 mg/dL) (whose GFR ranges from 60 to 89)

We investigated whether off-pump coronary revascularization provides a higher level of renal protection than traditional coronary revascularization with cardiopulmonary bypass.

Methodology: All participants in our research were administered the following treatment(s):

Preoperative evaluation and planning: The standard procedures were carried out during the preoperative preparation and evaluation phase. These procedures began with a comprehensive and extensive history taking and clinical examination of the patient, during which they took into consideration the patient's age, sex, and risk factors.

Laboratory Research: Electrolyte Evaluation: liver function tests, HBA1C, and Kidney function tests (eGFR/BUN/Creatinine levels).

ImagingStudies: Coronaryangiography, transthoracic Echocardiographic examination (TTE) and abdominal ultrasonography.

Intraoperativeassessment,techniqueandprotocols:

Anaesthesia: Fentanyl 5-10 g/Kg and Sodium Thiopental were used to initiate anaesthesia. Pancuronium 0.02 mg/Kg was

used with a hypnotic dosage of Propofol 0.5-1 mg/kg to facilitate the endotracheal intubation. The maintenance of anaesthesia was accomplished by inhaling 0.5-0.1% isoflurane. When necessary, further doses of 100-200 g of Fentanyl were administered.

Intraoperatively,monitoringof the hemodynamicsand vital signswas done for thearterial bloodpressure, arterial oxygensaturation,ECG, nasopharyngealtemperature, bladder temperature, urine output,Swan-Ganz(pulmonary artery catheter), IntraoperativeTEE.

SurgicalTechniqueinHarvestingtheConduits

InternalThoracicArtery:

PedicledITA:

standardtechniqueforthetwogroups.

SaphenousVeinGrafts

TheHarvestingTechnique:thestandardtechniqueforthetwo groups.

ProcedureofGroupA(TheOn-Pump)

CardiopulmonaryBypass

After pericardiotomy, the aorta and right atrium are cannulated with a single atrial venous catheter. In all situations, a double outlet cardioplegia cannula is placed into the aortic root. In all instances, cardiopulmonary bypass is performed at 32°C. Intraoperative myocardial protection is accomplished by antegrade, high-volume, single-dose cardioplegia at 8°C.

DistalAnastomoses: The distal anastomoses are typically done in the same order in all patients. Initialization begins with the right coronary artery, followed by the posterior RCA branches, the marginal branches of the circumflex artery, and the diagonal branches of the LAD.

ProximalAnastomoses: After the aorta is vented and the cross clamp is withdrawn, the proximal anastomoses are fashioned on the beating heart with the assistance of a vascular side-occlusion clamp after a hole is cut with a scalpel and a size 4.4/4.5 punch is opened. All proximal anastomoses are constructed with 6/0 polypropylene sutures.

ProcedureofGroupB(TheOffPump)

DistalAnastomoses: In most cases, the distal anastomoses are performed in the same sequence on each individual patient. The LIMA is attached to the vessel of the LAD first, then the diagonal branches of the LAD, the right coronary artery, the posterior RCA branches, and the marginal branches of the circumflex artery are joined in that order. When doing coronary artery bypass grafting on distinct patients, the distal anastomses are always done in an end-to-side fashion. In cases of sequential grafting, the anastomosis that is the most distal is an end-to-side anastomosis, which is then followed by anastomoses that are diamond-shaped (cross) or side-to-side. Sutures made of polypropylene with a 7/0 running gauge are used.

ProximalAnastomoses: The same technique as for on-pump CABG.

OperativeDataandParameters

Number and distribution of proximal and distal anastomoses, ischemia duration, total CPB time, incidence of surgical problems requiring re-establishment of CPB, and need for intraoperative inotropic support are some of the factors that were taken into consideration, intraoperative mean arterial blood pressure and central venous pressure, and incidence of hemodynamic instability during the procedure, particularly in group B, were recorded.

PostoperativeFollow-up: A standard postoperative data log was implemented. - Kidney function tests, including eGFR, blood urea, and serum creatinine, were documented. ICU stay, mechanical ventilator support and if it was prolonged, need for dialysis, mean hospital stay, operative morbidity defined as all complications starting within1 week of operation, including: Reoperation for bleeding, renal complications (acute renal failure), neurological complications (CVA), and any need for IABP support to aid the haemodynamic status.

StatisticalAnalysis:DatawasanalyzedbyMicrosoftOffice2010(excel)andStatistical.

Package for SocialScience (SPSS) version 16. Parametricdatawasexpressedasmean±SD ,andnonparametricdata was expressedas number and percentage ofthe total.

RESULTS

There was a statistical difference between on-pump CABG and off-pump CABG because on-pump CABG is a long operation due to the time required for cannulation and cardioplegia administration. Table 1 shows that there are no significant differences in the postoperative ICU stays of the two groups. Table 3 Contrary to what was projected for the prevalence of re-openings in patients, re-openings are more prevalent in off-pump patients (five patients vs two patients in the on-pump group) owing to a false feeling of security in the off-pump CABG group, which results in poor hemostasis (the fact that CPB leads to coagulaopathy). Table 4

Discussion

The severity of the condition necessitated comparison research between alternative treatment modalities, such as medical vs surgical /interventional and surgical versus interventional, as well as between different surgical procedures, such as off-pump versus on-pump.

In addition, the idea of co morbidities and risk factors among this vast population of patients offered a tremendous window of opportunity for addressing these risk factors and co morbidities in order to enhance the result.

Renal impairment before heart surgery is a significant risk factor. This has been consistently validated by robust epidemiological connections between increased plasma creatinine levels and worse postoperative outcomes. It has been proven that renal dysfunctions are an independent predictor of worse outcomes after CABG surgery. Recent studies have demonstrated that off-pump CABG (OPCAB) offers better outcomes than regular CABG in patients who have renal impairment. These findings come from many trials that were conducted.

In this research, we examined the early outcomes of isolated CABG performed on-pump vs off-pump in patients with preoperative mild to moderate blood creatinine increase (1.6 to 2.5 mg/dL) (whose eGFR 65-90). We will investigate if off-pump coronary revascularization provides a higher level of renal protection than traditional coronary revascularization with cardiopulmonary bypass.

However, study from the CASS registry and Jaglal et al. indicated a greater operative mortality in women (6) and (7), even after adjusting for comorbidities. They came to the conclusion that delaying treatment was the cause of the higher fatality rate. According to the findings of Fairer et al. (8), women reported more severe symptoms than men did while having the same degree of coronary disease as established by angiography. This suggests that there is a referral bias, with referral occurring later on in the evolution of the illness. It is not known if these perceived biases are true, whether they are connected to practitioners or patients, or whether they have a biological foundation; they provide a challenge for future study. (9).

Comparing our pump time to that of other studies revealed that our patients remained on CPB longer; however, when plotted against the number of distal anastomoses, we had a mean of 3.5 distal anastomoses per patient, whereas Loef et al., Pramodh et al., Vedin., and Ascione et al. all had less than 3.

In our investigation, the incidence of postoperative MI was equivalent to that of previous studies, and there was no difference between the on-pump and off-pump groups.

CABG for the incidence of acute postoperative renal failure necessitating dialysis, compare the postoperative rise in creatinine levels between the two groups. We discovered statistical significance for a higher level of creatinine postoperatively between the off pump group and the on pump group, demonstrating the influence of CPB on postoperatively elevated levels of creatinine.

There was no statistical significance established for the incidence of renal dialysis after surgery in either group.

Thus, we can link the influence of CPB on post-operatively high creatinine levels in

CABG patients who had elevated creatinine levels preoperatively.

In the majority of evaluated studies, including our own, renal function is maintained more effectively in patients undergoing off-pump CABG treatment as opposed to those undergoing on-pump CABG treatment.

Also, it is noteworthy that, in our study, a greater proportion of patients developed PRD requiring dialysis postoperatively than in other studies, particularly in the on-pump group. However, this is to be expected, as the inclusion criteria for all of our patients was "patients with preoperative renal impairment (serum creatinine 1.6-2.5 mg/dl)," whereas some of these other studies included patients with normal serum creatinine preoperatively and measured the severity of the disease beyond n

Numerous studies have been conducted to investigate the results of heart surgery in patients who have reached the terminal stage of their renal disease (14). However, the prognosis of persons with mild or moderate renal impairment who are not receiving dialysis has only been documented by a few number of studies (15). Despite this, the number of patients who have this clinical condition is far higher than the percentage of patients who have renal failure that requires dialysis; as a result, it is very necessary to identify and define the risk in this patient group (16).

Acute renal failure (ARF), also known as postoperative acute renal failure, is a well-known complication that may occur anywhere from 5 to 31% of the time after cardiac surgery. (17). ARF that is severe enough to need dialysis occurs in between 1 and 5 percent of individuals who have had open-heart surgery and has a strong correlation with postoperative morbidity and mortality (18). There is a wide range in the overall mortality rate after open-heart surgery, from 2% to 8%. (19). The risk of developing ARF is proportional to the complexity of the open-heart procedure that was carried out. The incidence of acute renal failure (ARF) in patients who had typical coronary artery bypass grafting was the lowest at 2.5%, while the incidence of ARF in patients who required dialysis (ARF-D) was the lowest at 1%. This was followed by valvular surgery at 4.6% and 3.3%, respectively (20)

As noted earlier, patients were determined to have PRD if their creatinine level increased by 0.9 mg/dL or more over the pre-operative level, or if the postoperative level reached 2.1 mg/dL or more. According to the same criteria used by Antunes et al. (16), four patients without pre-operative renal issues developed PRD, while 11 of the total 25 patients had PRD. Our statistical investigation of blood creatinine and its related GFR estimated using the Cockcroft and Gault method over the first three postoperative days revealed a strong correlation between pre-operative renal impairment and its occurrence after surgery. These findings were previously shown by Zakeri et al. (21) who compared 458 individuals with moderate renal impairment to 3945 participants with a normal preoperative blood creatinine level.

In addition to serum creatinine measurements and subsequent GFR estimates, daily urine output and fluid balance calculations were also performed. In contrast, no statistical significance was shown for the fluid balance calculation. This result was consistent with the retrospective analysis of medical records conducted by Najafi et al. (22) who stated that occult renal dysfunction may be present in the presence of normal serum creatinine levels; therefore, creatinine clearance and GFR are much more specific in assessing renal functions.

Length of stay (LOS) takes us to an important topic raised by several research, notably Dasta et al. (23), namely the expenses of stay for patients who acquired postoperative renal impairment based on the RIFLE criteria. From the day of surgery to the day of discharge, Dasta et al. (2008) computed the cost-center expenditures for each patient, which comprised ICU room and supplies, laboratory, pharmacy, dialysis, and mechanical ventilation (total postoperative costs). At the conclusion of the study, the researchers validated the

prediction that patients with PRD had higher expenses of charges; in reality, all expenditures and lengths of stay were almost twice the norm (23). Due to the absence of well organised perioperative patient IT data, this issue could not be clarified in our research.

As a general assessment of our study, it is fair to say that our study design was very similar to that of multiple recent studies in terms of using a prospective case-control study to divide the total population undergoing isolated on-pump CABG surgery into a group with normal renal function using both serum creatinine and GFR and a group with abnormal range values. Using the Cockcroft-Gault equation, we could accurately predict the types of patients who would likely develop PO PRD. Utilizing several perioperative preventive measures effectively reduces the number of patients susceptible to this morbidity issue.

Conclusion

The analysis of postoperative outcomes revealed no association between abdominal ultrasound findings and renal impairment. General Preventive Measures to Prevent Renal Dysfunction Following Cardiac Surgery must be implemented in all patients, with specific consideration for those with prior renal dysfunction. A good treatment will ultimately use tactics that target these numerous routes. This combined method would target hemodynamic, inflammatory, and oxidative processes and operate at proximal cellular damage sites.

General Measuresto prevent renal dysfunction after Cardiac Surgery should be utilized in all patients with special attention to those with preoperative renal dysfunction.

Regarding postoperative renal dysfunction and need for dialysis, results were in favor of the off-pump technique. Renal function is better preserved in patients undergoing off-pump. CABG than those undergoing on-pump CABG. CPB is associated with a higher risk for PRD, and this injury is associated further with substantial morbidity and mortality.

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Table1:**Comparisonbetweenoperativedataofthestudiedgroups**

	On-pump		Off-pump		P value
	Mean	SD	Mean	SD	
TotalPumpTime$_{min}$	112.40	37.80			
TotalischemicTime$_{min}$	67.50	24.18			
TotalOPTime$_{min}$	234.60	57.54	199.77	43.07	**0.004***
NoofDistalanasomoses.	3.50	0.94	2.93	0.81	**0.558**

*Pvalue≤ 0.05isconsideredsignificant.

Table2:**Comparisonbetweenpostoperativelaboratorydataamongstudiedgroups**

Postoperative	On-pump		Off-pump		Pvalue
	Mean	SD	Mean	SD	
Hg$_{g/dl}$	9.42	1.10	10.35	0.89	**0.006***
CK-MB$_{U/i}$	45.61	24.07	45.27	27.78	**0.960**
Troponin$_{U/i}$	5.26	4.87	1.77	1.48	**0.007***
RBS$_{mg/dl}$	157.43	57.27	135.73	39.81	**0.095**
ALT$_{U/i}$	27.63	16.74	31.73	12.09	**0.282**
AST$_{U/i}$	65.40	35.19	59.83	32.98	**0.530**
Bil.(Total)$_{mg/dl}$	0.78	0.46	0.92	0.29	**0.289**
K$_{mmol/l}$	5.22	0.62	5.06	0.38	**0.236**
Na$_{mmol/l}$	146.40	4.61	144.80	5.67	**0.235**
Cl$_{mmol/l}$	109.93	4.73	110.67	5.36	**0.577**
Mg$_{mmol/dl}$	1.32	0.30	1.22	0.25	**0.170**
BUN$_{mg/dl}$	49.00	15.36	32.50	15.43	**0.000***
Creat.$_{mg/dl}$	2.62	0.87	1.98	0.66	**0.002***
eGFR$_{ml/min/m2}$	30.87	11.04	39.84	13.68	**0.012***

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Postop Albuminuria$_{g/24h}$	1.079	0.828	1.32	1.23	**0.370**

*Pvalue≤ 0.05isconsideredsignificant.

Table3:**ComparisonbetweentheICUstay(indays)amongbothgroups**

	On-pump		**Off-pump**		**P value**
	Mean	**SD**	**Mean**	**SD**	
ICUstay(days)	4.667	3.367	3.70	2.15	**0.191**

*Pvalue≤ 0.05isconsideredsignificant.

Table4:**Theincidenceofcomplicationsamongbothgroups**

	On-pump		**Off-pump**	
	Number	**%**	**Number**	**%**
MI	3	**10.00**	3	**10.00**
Arrhythmias	7	**23.33**	9	**30.00**
Re-opening	2	**6.67**	5	**16.67**
Dialysis	6	**20.00**	3	**10.00**

Table5:comparestheresultofoffpumpCABG vsonpump

	Offpump	**On pump**	**Pvalue**
Ptn. DevelopedPRD with need for Dialysis	**3/30**	**6/30**	**0.470**
Ptn.With elevated level ofcreatinine postoperative	**3/30**	**13/30**	**0.009**