International Journal of Cardiovascular Research

Immediate Proximal Coronary Graft Anastomosis After Completion of Related Distal Anastomosis, During Off Pump Cabg; Is It Efficient?

Mahmoud Khairy¹*, Eman NasrEldin² and Ali Elsharkawi³

Abstract

Objective: Evaluation of early outcome and safety of proximal coronary graft anastomosis immediately after finishing its related distal anastomosis, during beating heart CABG. It presents rapid reperfusion of ischemic myocardium. So, it could reduce intraoperative hemodynamic instability.

Methods: The results in 27 patients underwent off pump CABG with simultaneous proximal coronary graft anastomosis after the end of its related distal anastomosis (group A), were compared with the results in 28 patients had conventional late all proximal anastomoses after completion of all distal anastomoses (group B). Effectiveness of simultaneous proximal coronary graft anastomosis was evaluated during and after the operation by clinical, hemodynamic, electrocardiographic and echo-cardio graphic assessment.

Results: Conversion to cardio-pulmonary bypass (CPB) was significantly lower in immediate proximal anastomosis (group A). The ischemic time for each coronary territory (the sum of the time without distal perfusion for each coronary artery after finish of distal anastomosis) was lower significantly in group A than group B (17.6 vs. 24.0 minutes).

The patients requiring high dose inotropic support were lower in (group A). Laboratory results showed significant lower myocardial enzyme levels at 1st and 2nd days after operation in group (A).

During 6 months follow up, ejection fraction (E.F) in group A was better than in group B.

Conclusions: Immediate proximal coronary graft anastomosis resulted in superior myocardial protection when compared to late all proximal coronary anastomosis during off-pump coronary artery grafting.

Keywords

Off-pump CABG; Immediate coronary perfusion; Sequance of anastomosis

Introduction

Off pump CABG patients were changed to include higher risk patients with poor left ventricular functions. So, it might need rapid coronary perfusion during coronary surgery [1].

*Corresponding author: Mahmoud Khairy, Associate Professor, Department of cardiothoracic surgery, Faculty of Medicine, Assiut University, Assiut 71526, Egypt, Tel: 00201224579171; E-mail: mahkhairy02@yahoo.com

The suitable sequence of anastomoses during CABG surgery is controversy. The use of distal coronary anastomoses first, is a long standing clinical practice. Construction of all proximal anastomoses first has advantages [2].

The need for prompt recovery of any impairment in myocardial performance after each anastomosis is crucial during off pump CABG, before occlusion of next target coronary vessels. Otherwise, cumulative regional ischemia may become so extensive with failure of pump cardiac functions [3].

Additive ischemia with hemodynamic instability during off-pump procedures could be compromise the completeness of revascularization. It might raise mortality, morbidity and hospital stay days [4].

In the practice, ischemic preconditioning of the target coronary bed has been used to face the myocardial dysfunction, due to coronary occlusion with variable success [5]. Distal coronary bed perfusion can be done during the distal anastomosis followed by continued perfusion through the graft after finish of distal anastomosis. It can be offered passively by an intracoronary shunt or a shunt from the aorta, or presented actively by a shunt associated to a pump from the ascending aorta [6].

We present our initial clinical experience with new sequence of coronary graft anastomosis which is immediate coronary perfusion after each distal coronary graft anastomosis during off pump CABG, through immediate construction of its related proximal anastomosis and evaluate its safety and efficacy.

Patients and Methods

Fifty five patients (mean age 57.6 ± 9.2 years) of multivessel coronary artery disease including 42 male and 13 female were enrolled in this randomized prospective and comparative study during the last 2 years. They signed an informed consent, 27 patients from them undergo beating heart CABG with reconstruction of each proximal coronary graft anastomosis, immediately after finish of its distal anastomosis (group A). Other 28 patients submitted to same procedure with conventional late proximal anastomoses after completion of all distal anastomoses (group B). Comparison was done for the pre operative, operative and postoperative data between both groups to determine safety and efficiency of immediate coronary perfusion by reconstruction of proximal coronary graft anastomosis after completion of its related distal anastomosis during beating heart CABG.

The preoperative data of the study patients are shown in (Table 1).

Patients were candidates for isolated off pump CABG, with at least one non-LAD saphenous vein bypass graft. Target coronary artery obstruction was ≥ 50% through angiography. Evaluation of the risk factors were done by Euro score [7].

Exclusion criteria included; ejection fraction<35%, ventricular aneurysm, associated valve disease, renal impairment with creatinine level of>2 mg/dL, after CABG and age more than 80 years. Also, patients had intra-myocardial target coronary arteries or patients had heavily calcified aorta on chest X-ray or on intraoperative palpation of the aorta were excluded.

Table 1: Preoperative characteristics in Immediate and Late proximal anastomosis Groups.

Variable	Immediate proximal anastomosis *Group A* *(N = 27)*	Late proximal anastomosis *Group B* *(N = 28)*
Age (years) *(mean ± SD)*	56.6 ± 11.1	58.4 ± 9.4
Sex: *Male/Female*	20/7	22/6
NYHA class (N)		
I or II	5	5
III or IV	22	23
Preoperative Ejection fraction	54.41± 11.17	53.41± 12.51
Affected main vessels (n): *Double / Triple vessels*	9/18	8/20
Euro score (risk score)	2.31±1.72	2.54±1.25

- SD = Standard deviation; NYHA = New York Heart Association.

Operative technique

All patients were subjected to off pump CABG technique. Pedicled left internal mammary artery (LIMA) harvesting was done under direct vision. Heparin was provided (100 IU/kg) throughout the surgery; the activating clotting time (ACT) was about 300 seconds. At the end of operation heparin was completely neutralized with protamine.

After grafts harvesting and its preparation, identification of the target anastomosis was done. Octopus III stabilizer (Medtronic production) was used for regional cardiac fixation.

Trial lifting of the heart to expose the lateral and posterior coronary vessels was done, to check suitability for an off pump procedure. Big changes in arterial pressure or electrocardiogram (ECG) were carefully looked for. If the heart did not tolerate this procedure, on pump CABG was used (these cases are excluded from our study).

In general, left internal thoracic artery was anastomosed individually to a left anterior descending artery in the studied patients and saphenous vein was used to bypass the remaining target coronary vessels.

In both groups, 4-5 mm arteriotomy in target coronary vessel was done for distal anastomosis with running suture of 7/0 polypropylene (Prolen, Ethicon).

In non-critical coronary stenosis, ischemic preconditioning was applied through 3 minutes clamping of the target coronary artery then 5 minutes of reperfusion by release of the clamp. Also intraluminal coronary shunt (Medtronic production) was used. Either gas blowing was used to obtain a good bloodless field, or saline insufflation [8].

Proximal anastomoses were performed in both groups under a partial occlusion aortic clamp; with the use of running suture technique with 5/0 polypropylene (Prolen, Ethicon).

In Immediate proximal anastomosis group (A), usual sequence of distal coronary graft anastomosis during off pump CABG was used. In which, LIMA to LAD graft is usually first; follwed by the anterior, lateral (OM), and lastely inferior vessels (PDA, RCA). But, each proximal coronary graft anastomosis was constructed immediately after finish of its related distal anastomosis. So, it could provide immediate and continuous coronary blood flow to the related ischemic myocardial bed. The exception was grafting the collaterized vessel first.

In Late proximal anastomosis group (B), proximal anastomoses were done after completion of all distal anastomoses.

Maintenance of arterial blood pressure and hemodynamic stability was done by giving IV fluid, the head-down position or intraoperative vasoconstrictor (norepinephrine).

Intraoperative conversion from OPCAB to on pump CABG could take place if hemodynamic instability could not be controlled despite aggressive fluid or catecholamine administration.

At the end, the chest was closed in anatomical layers after draining the mediastinum and the opened pleura.

Postoperative assessment

Patients' data were analyzed including inotropic support >24 hours, use of intra-aortic balloon, myocardial infarction attack, ECG ischemia, coronary re-intervention, new arrhythmia, cerebrovascular stroke, renal impairment, reopening and mortality. Operative mortality was considered as death inside the hospital or within one month postoperatively.

All patients received postoperative aspirin (150 mg/day) and clopidogrel (75 mg/day for three months), starting on the next day after surgery.

Baseline preoperative cardiac markers were done, and repeated at 1st, 2nd and 3rd postoperative day.

All patients were checked after discharge by rest electrocardiography (ECG), chest X-ray and echo-cardiography to assess the global left ventricular function.

During 3-6 months follow up; evaluation of all patients was done by clinical examination, electrocardiography and echo-cardiography.

Statistical analysis

Data and results are presented as mean ± Standard deviation. Statistical comparison between groups was performed through the *t*-test. *P* value of ≤ 0.05 was considered to indicate a significant difference, and highly significant at *P*<0.01.

Results

This article presents clinical and echo graphic results (through 6 months) of 27 patients underwent off pump CABG with immediate coronary bed perfusion by establishment of proximal coronary graft anastomosis after finish of its related distal anastomosis (group A), in comparison with another 28 patients received late proximal anastomoses after completion of all their distal anastomoses (group B). No significant differences were observed between both groups regarding the preoperative characteristics (Table 1).

Table 2 showed the peri- and the postoperative data of the study subjects.

There was no significant difference concerning operative time. But, there is significant difference between immediate proximal anastomosis group (A) and late proximal anastomosis group (B) concerning conversion to C.P.B (P<0.05) where it was one patient (2.7%) in (group A) vs. 3 (8.4%) in (group B).

The mean ischemic time for each coronary bed (the time that each coronary territory was without distal coronary perfusion) was significantly lower in immediate proximal anastomosis group (A) (17.6 ± 6.4 minutes) than in late proximal anastomosis group (B) (24.0 ± 8.6 minutes) (P<0.05).

No significant difference between the groups concerning the total days of ICU stays where it was 2.61 ± 1.81 vs. 2.81 ± 1.29 days. The mechanical ventilation time was 5.51 ± 3.5 hours in immediate proximal anastomosis group and 6.31 ± 3.32 hours in late proximal anastomosis group (P>0.05). The total postoperative hospital stay was 6.70 ± 2.92 days in group A vs. 7.25 ± 3.13 days in group B (P>0.05) (Table 2).

Laboratory study

Table 3 revealed insignificant difference between both groups (A and B), concerning preoperative cardiac markers and serum cytokines.

Table 4 revealed significant lower myocardial enzymes at 1st and 2nd postoperative days in group (A) than group (B).

Postoperative complications

Regarding to the postoperative events, there were 1/27 cases of immediate anastomosis group required high inotropic support dose (adrenaline>0.15 ug/kg/min) during the operation and continued at postoperative 1st day while 4/28 patients from group (B) needed that (Table 5).

Moreover, 3/27 cases from group (A) and 5/28 cases from group (B) developed new arrhythmias; mostly AF (atrial fibrillation) and there was no statistically significant differences.

Furthermore, group (A) showed one case of early postoperative mortality as a result of renal impairment. Group (B) showed one case of intraoperative mortality because of low cardiac output.

Follow up

No deaths recorded during 3-6 months postoperatively. Also, no patients developed attack of myocardial infarction or recurrent angina. None of the patients required additional revascularization.

Postoperative ejection fraction (E.F) was better in group (A) than group (B) (53.51 ± 9.1 vs. 52.25 ± 10.9); but there was no statistical significant difference between both groups.

Table 2: Perioperative and postoperative characteristics among patients in Immediate and Late proximal anastomosis Groups.

	Immediate proximal anastomosis Group A (N=27) Mean ± SD	Late proximal anastomosis Group B (N=28) Mean ± SD	P-Value*
Operative time(min)	213.2 ± 52.1	230.4 ± 32.7	>0.05
Distal anastomosis (n)	3.35 ± 0.36	3.14 ± 0.45	>0.05
Proximal anastomosis (n)	1.80 ± 0.76	1.76 ± 0.35	>0.05
Ventilation time (hours)	5.51 ± 3.5	6.31 ± 3.32	>0.05
ICU stay (days)	2.61 ± 1.81	2.81 ± 1.29	>0.05
Postoperative hospital stays(days)	6.70 ± 2.92	7.25 ± 3.13	>0.05
Postoperative E.F	53.51 ± 9.1	52.25 ± 10.	>0.05

*P is the comparison between both groups. P>0.05=insignificant, P ≤ 0.05=significant.
-SD=Standard Deviation; ICU=Intensive Care Unit; E.F= Ejection Fraction

Table 3: Preoperative cardiac markers between Immediate Group A and Late Group B.

Myocardial markers	Group A (Immediate proximal anastomosis) Mean ± SD	Group B (Late proximal anastomosis) Mean ± SD	P-Value *
CK (IU/L)	66.52 ± 56.26	51.54 ± 36.66	>0.05
LDH (IU/L)	61.33 ± 21.04	56.52 ± 24.63	>0.05
CK MB (IU/L)	31.65 ± 25.2	26.35 ± 11.15	>0.05

*P is the comparison between both groups. P > 0.05 = insignificant, P ≤ 0.05 = significant.

- CK = creatinine kinase; LDH = lactate dehydrogenase; CK MB = creatinine kinase MB; SD = Standard deviation.

Table 4: Postoperative cardiac markers between Immediate Group A, and Late Group B.

Myocardial markers	1st Day Group A Mean±SD	1st Day Group B Mean±SD	P*	2nd Day Group A Mean±SD	2nd Day Group B Mean±SD	P*	3rd Day Group A Mean±SD	3rd Day Group B Mean±SD	P*
CK (IU/L)	722 ± 516	1480 ± 1140	<0.05	658 ± 402	1008 ± 472	<0.05	343 ± 250	723 ± 437	>0.05
LDH (IU/L)	474 ± 200	548 ± 142	>0.05	421 ± 206	531 ± 150	>0.05	261 ± 119	312 ± 132	>0.05
CKMB(IU/L)	34 ± 15	61 ± 42	<0.05	30 ± 24	48 ± 43	>0.05	14 ± 11	22 ± 21	>0.05

*P is the comparison between both groups. P > 0.05 = insignificant, P ≤ 0.05 = significant.

- CK = creatinine kinase; LDH = lactate dehydrogenase; CK MB = creatinine kinase MB; SD = Standard deviation.

Table 5: Postoperative events among patients in Immediate and Late proximal anastomosis Groups.

	Immediate Group A (N=27) N (%)	Late Group B (N=28) N (%)	P-Value*
-ECG new ischemia	3 (8.1%)	4 (11.2%)	>0.05
- Arrhythmia	3 (8.1%)	5 (14%)	>0.05
- Conduction defect	2 (5.4%)	3 (8.4%)	>0.05
-Intra-aortic balloon	2 (5.4%)	2 (5.6%)	>0.05
-Inotropic support (adrenaline)>0.15 ug/kg /min for 1 day	1 (2.7%)	4 (11.2%)	**<0.05**
-Resternotomy for bleeding	2 (5.4%)	3 (8.4%)	>0.05
- Pericardial effusion	3 (8.1%)	2(5.6%)	>0.05
- Mediastinitis	2 (5.4%)	1(2.8%)	>0.05
-Neurological complications	2 (5.4%)	1(2.8%)	>0.05
- Renal impairment	1 (2.7%)	0(0%)	>0.05
- Mortality	1 (2.7%)	1(2.8%)	>0.05
*P is the comparison between both groups. P>0.05=insignificant, P ≤ 0.05=significant			

Discussion

The off-pump CABG is used in patients, are not suitable for CPB, cannulation or hypothermia. Also, it is preferable in patients with COPD or renal impairment. In developing countries, the beating heart procedures are more cost saving than the use of CPB [9].

Incomplete revascularization and low quality of anastomosis are the most causes of mortality and morbidity in off-pump coronary artery grafting [10]. This may due to technical difficulties or the hurry of the surgeon after occurrence of hemodynamic instability or ischemic event during coronary anastomosis [4].

During beating heart CABG technique; there is additive intermittent ischemia with reconstruct of distal anastomosis, beside the original ischemia.

This study was performed to evaluate the clinical effect of immediate providing coronary blood flow after finish of each distal graft anastomosis, during the off pump procedure (group A). Then, compare it with the effects of the intermittent but cumulative ischemia that occurs when reconstruction of all proximal anastomoses were done after finish of all distal anastomoses, during traditional off pump CABG (group B).

Immediate coronary perfusion has been used before by reconstruction of proximal anastomoses firstly [3] or by use of active coronary perfusion device or by means of an intracoronary shunt or a shunt from the aorta, with accepted results [11-14].

Also, the usual start with LIMA to LAD anastomosis during beating heart CABG is considered as immediate coronary perfusion.

In current study, the groups had no difference in total number of distal anastomosis which allows better matching and comparison of the two patients groups.

To control the bias in operative judgment in this study, nonselected patients were electively randomized into the study. Cardiac positioning, stabilization, and grafting techniques were similar in all patients.

Immediate proximal anastomosis technique is a competitive method compared to conventional late proximal anastomosis. In our comparison, it significantly reduced the intraoperative urgent conversion to cardiopulmonary bypass (CPB), with a cost saving of on pump equipment such as cannulas, prime fluids and oxygenators [15].

Hemodynamic stability and preventing regional dysfunction secondary to selective graft perfusion was proved in previous study.

The explanation was immediate coronary perfusion of the primary grafted myocardial region, providing an additional safety margin for subsequent coronary occlusion in multivessel grafting [11].

Myocardial damage is lower with use of immediate proximal anastomosis technique as reflected in the laboratory finding, which showed significant lower cardiac enzymes at early postoperative days. Also, it had low number of patients needed high dose of inotropic support.

The mean total ischemic time for immediate proximal anastomosis group (A) patients (17.6 ± 6.4 minutes) was significantly lower than in late proximal anastomosis group (B) (24.0 ± 8.6 minutes) (P<0.05), because of the completed free grafts were not perfused until its proximal anastomosis was finished. Low ischemic time in group A may explain its low myocardial damage. This finding is corresponding with previous study with use of active coronary perfusion device [6].

In addition, immediate proximal anastomosis technique may facilitate myocardial performance and function by immediately reaching cardio protective or vasoactive drugs from body arterial system to grafted myocardium. This technique has been advocated with increasing frequency for multi-vessel coronary artery disease.

However, when systemic pressures fall during mechanical manipulation of the heart (especially in grafting the posterior wall), coronary perfusion pressure decreased and more myocardial dysfunction may happen.

Our technique has some disadvantages like subsequent retraction for doing distal coronary grafts anastomosis of lateral cardiac wall. So, the mammary graft and grafts to the distal right coronary system must be made extra-long before extreme retraction of the heart for lateral wall anastomoses. Proper graft length can be judged by observing the grafts with the heart in its anatomic position.

Some authors used hybrid approach for selected patients with multivessel disease. They used off-pump bypass for the LAD and staged PCI for the other arteries. However, the failure rate and need for reintervention of PCI were likely to compromise the results with additional cost [16].

Buffolo et al. did not use the off-pump procedure in patients had obtuse marginal branches disease to avoid operative ischemic events [17].

Limitations of this study were small number of patients and study of early term results. Other multicenter studies with more patients

and examination of later results at>6 months may prove the possible superiority of our method in comparison to the conventional one.

Most patients in our study had good left ventricular function; theoretically, they had greater reserve for tolerating ischemia. In addition, patients with poorly contractile ischemic ventricles may benefit more from this technique.

Patients with calcified ascending aortic artery are excluded from our study. Because, we think they are not suitable for repeated aortic cross clamping; which is mandatory in our new technique.

In this study, the safety and efficacy of this new coronary graft sequence could be proven. All standard targets for coronary revascularization were reached with this anastomosis sequence. Its application was possible and safe.

Conclusion

In our experience, immediate proximal anastomosis technique during off-pump coronary artery grafting is safe and applicable. It provide numerous advantages over conventional late proximal anastomosis in facilitating immediate perfusion of grafted myocardial regions and prevent cumulative ischemic dysfunction with enhancement of myocardial protection and hemodynamic stability; It is cost effective by avoidance of urgent conversion to cardiopulmonary bypass; and It facilitate complete revascularization. It met current accepted postoperative complications, mortality and intensive care unit stay. But, it must avoid patients having highly calcified aorta.

Conflict of Interest

No.

References

1. Bedi HS, Arsiwala S, Sharma V, Bhavani S, Pavan P, et al. (1991) Coronary artery bypass grafting in patients with calcific aortitis. J Thorac Cardiovasc Surg 102: 163-164.

2. Calafiore AM, Teodori G, Di Giammarco G, Vitolla G, Maddestra N, et al. (1999) Multiple arterial conduits without cardiopulmonary bypass: Early angiographic results. Ann Thorac Surg 67: 450-456.

3. Bonatti J, Hangler H, Hörmann C, Mair J, Falkensammn J, et al. (1998) Myocardial damage after minimally invasive coronary artery bypass grafting on the beating heart. Ann Thorac Surg 66: 1093-1096.

4. Tasdemir O, Vural KM, Karagoz H, Bayazit K (1998) Coronary artery bypass grafting on the beating heart without the use of extracorporeal circulation (review of 2052 cases). J Thorac Cardiovasc Surg 116: 68-73.

5. Grubitzsch H, Ansorge K, Wollert H, Eckel L (2001) Stunned myocardium after off-pump coronary artery bypass grafting. Ann Thorac Surg 71: 352-355.

6. Vassiliades TA, Nielsen JL, Lonquist JL (2002) Coronary perfusion methods during off-pump coronary artery bypass: Results of a randomized clinical trial. Ann Thorac Surg 74: S1383-S1389.

7. New EuroSCORE II (2011) - euroSCORE.org. EACTS, Lisbon.

8. Khairy M (2018) Coronary clamping versus shunting during off pump CABG, early experience and outcome. Journal of the Egyptian Society of Cardio-Thoracic Surgery 2: 95-99.

9. Bedi HS, Suri A, Kalkat MS, Sengar BS, Mahajan V, et al. (2000) Global myocardial revascularization without cardiopulmonary bypass using innovative techniques for myocardial stabilization and perfusion. Ann Thorac Surg 69: 156-164.

10. Reichenspurner H, Boehm DH, Welz A, Schmitz C, Wildhirt S, et al. (1998) Minimally invasive coronary artery bypass grafting (port-access approach versus off-pump techniques). Ann Thorac Surg 66: 1036-1040.

11. Guyton RA, Thourani VH, Puskas JD, Shanewise JS, Steele MA, et al. (2000) Perfusion-assisted direct coronary artery bypass (selective graft perfusion in off-pump cases). Ann Thorac Surg 69: 171-175.

12. Puskas J, Thourania V, Vinton-Johansen J, Guyton R (2001) Active perfusion of coronary grafts facilitates complex off-pump coronary artery bypass surgery. Heart Surg Forum 4: 65-69.

13. Steele M, Palmer Steele C (2000) Perfusion technique for perfusion-assisted direct coronary artery bypass (PADCAB). J Extra-Corpor Technol 32: 158-161.

14. Sydzyik RT, Stammers AH, Zavadil DP, Deptula JJ, Christensen KA. (1997) Evaluation of a new generation cardioplegia administration system. J Extra-Corpor Technol 29: 145-153.

15. Elmahrouk AF, Hamouda TE, Kasab I, Ismail MF, Jamjoom AA (2017) Short term outcome of conventional versus off-pump coronary artery bypass grafting for high-risk patients. J Egypt Soc Cardiothorac Surg 26: 24-29.

16. Subramanian VA (1997) Less invasive arterial CABG on a beating heart. Ann Thorac Surg 63: S68-S71.

17. Buffolo F, Andrade CS, Branco J, Agular LF, Teles CA, et al. (1996) Coronary artery bypass grafting without cardiopulmonary bypass. Ann Thorac Surg 61: 63-66.

Author Affiliations   Top

¹Cardiothoracic Surgery Department, Assiut University Hospital, Assiut, Egypt

²Department of clinical pathology, Assiut University Hospital, Assiut, Egypt.

³Cardiology Department, National Heart Institute, Cairo, Egypt