The Egyptian Cardiothoracic Surgeon

DOI: 10.35810/ects.v5i2.252

Vol. 5, No. 2, 34 - 39

Original Article

Early results of total arterial off-pump coronary artery bypass grafting using bilateral internal mammary arteries

Ayman Abdelmotelb[1], Sarju Ralhan[2], Mohsen Saber[1]

[1] Department of Cardiothoracic Surgery, Faculty of Medicine, Sohag University, Sohag, Egypt

[2] Department of Cardiac Surgery, DMC heart institute, ludhiana, india

Abstract

Background: The optimal coronary artery bypass grafting (CABG) technique is still evolving. This study aimed to evaluate the early results of the total arterial off-pump technique using bilateral internal mammary arteries.

Methods: This study was performed from May 2018 to May 2019 at a cardiac surgery center in India. It included 200 patients with coronary artery disease who had off-pump CABG using bilateral internal mammary arteries. The patients had follow-ups for three months. There were 50 females, and the mean age was 50±10 years.

Results: Conversion to on-pump was required in one case (0.5%). The use of complete vein grafts was needed in three cases (1.5%), and vein graft extension was done for two cases (1%). Intra-aortic balloon pump was used in one case (0.5%). Postoperative re-exploration for bleeding was done in two cases (1%), and sternal dehiscence or deep infection occurred in two cases (1%). A pacemaker was used in one case (0.5%), and postoperative need for dialysis occurred in three patients (1.5%). No operative mortality or postoperative stroke was reported. Redo surgery was required in one patient (0.5%).

Conclusions: Off-pump total arterial revascularization technique using bilateral internal mammary arteries could have an acceptable early outcome.

KEYWORDS

Off-pump; Total arterial revascularization; Bilateral internal mammary arteries

Article History

Submitted: 19 Sep 2022

Revised: 12 Oct 2022

Accepted: 30 Oct 2022

Published: 1 Mar 2023

Introduction

The burden of ischemic heart disease is increasing globally [1]. Surgical options for coronary revascularization are still evolving and challenging, especially with the increased use of percutaneous coronary interventions (PCI) [2]. This motivated cardiac surgeons to use more challenging techniques to achieve superior long-term symptomatic and cosmetic results, such as total arterial and robotic coronary revascularization.

The first coronary bypass described was the off-pump approach [3]. The off-pump techniques gained popularity again because of cardiopulmonary bypass complications and the use of coronary shunts and stabilizers.

Enforced by the big challenge with therapeutic coronary angiography and the need to give better long-term results with surgical coronary revascularization, many cardiac surgery centers worldwide shifted to total arterial revascularization, with the use of bilateral internal mammary arteries hoping to improve long-term patency and survival [4]. In this study, we reported the early outcomes of the off-pump total arterial

Corresponding author: Ayman Abdelmotelb lastdoctorlastdoctor@yahoo.com

revascularization technique in a tertiary referral center.

Patients and Methods

Design and patients

This study is a prospective non-randomized clinical study that included 200 patients. We included all patients who had off-pump total arterial revascularization using bilateral internal mammary arteries from May 2018 to May 2019. Patients who had on-pump CABG and those with concomitant cardiac procedures were excluded.

All patients were done in a single heart institute in India by two expert surgeons. The study was conducted after the approval of the institute to get the patients' data; all patients were done with the same technique.

Technique:

We used short midline sternotomy incisions, especially for younger and diabetic patients. We did not use bone wax; however, in diabetic patients, we used vancomycin in a gelatinous form immediately after sternotomy. We opened the pericardium widely in the midline. We extended it inferiorly toward IVC (inferior vena cava) on the right side and the pleura-phrenic surface on the left side. It can be extended superiorly toward SVC (superior vena cava) if needed.

We tried to get the long left internal mammary artery (LIMA) in pedicle form. We tried to preserve the pleura intact, especially the upper part, to prevent the lung from pushing LIMA and for better postoperative respiratory function. We used LIMA in narrow pedicle form and decided the length needed according to the target site.

We harvested the right internal mammary artery (RIMA) in semi-skeletonized form. We used it as a free graft connected proximally to the LIMA by making (Y) anastomosis between both arteries.

We did all anastomoses using an off-pump technique with a stabilizer. We started with LIMA-LAD anastomosis, followed by the other coronary targets

We used shunts to maintain an adequate hemodynamic and coronary blood supply, decrease bleeding, and ensure patent anastomosis. Multiple sizes are available, and shunts can be removed easily before the last two sutures keeping the last sutures slightly loose during shunt pull.

We used the parachuting technique, but the tie-down technique might be a good option in a small narrow field, especially the lateral side, as the field is narrow, especially with sequential anastomosis. To prevent kinks, it is important to take fixation sutures proximal and distal to each anastomosis.

We check adequate hemostasis before closure. We either use wires or bands to close the sternum. We put mediastinal drains as a routine and chest drain according to pleura opened.

Statistical analysis:

We collect the data related to intraoperative events: the need for conversion to on-pump, use of complete vein grafts, use of vein graft extension, use of IABP (intra-aortic balloon pump), pacemaker, and mortality.

Postoperative events included exploration for bleeding, sternal dehiscence or deep wound infection, new ischemic changes by ECG (electrocardiography), need for dialysis, stroke and redo surgery during 1st three months.

Continuous data were described as mean and standard deviation, and categorical data as numbers and percentages. Descriptive analysis was performed using SPSS (IBM Corporation, Armonk, NY, USA).

Results

Two hundred patients were included in our study; 75% of them were male patients, 40% of our patients were diabetic, and 10% had preoperative low ejection fraction. (Table 1)

Conversion to on-pump occurred in one case (5%) with a cardiac arrest during obtuse marginal grafting. Cardiopulmonary resuscitation (CPR) was started, immediate conversion to on-pump was

done, and the remaining grafts were done on cardiopulmonary bypass with a beating heart with a smooth postoperative course.

Table 1: Demographic data of the included patients

	N= 200
Gender	
Male	150 (75%)
Female	50 (25%)
Age (in years)	
30-50	75 (37.5%)
50-70	95 (47.5%)
More than 70	30 (15%)
Diabetic patients	80 (40%)
Preoperative low ejection fraction patients	20 (10%)

Vein grafts were used in 3 cases (1.5%); 2 patients had small PDA and small PLV with good caliber distal RCA, and the length or RIMA was too small to reach the target area for grafting, especially with both big-size hearts. The third patient's LIMA was injured during harvesting, and the surgeon preferred to get a vein than take the risk of graft poor flow LIMA.

The vein graft extension was used for 2 cases (1%) as the RIMA was short of reaching PDA, so it was extended with a small part of the saphenous vein.

IABP was used in 1 case (0.5%) as the patient could not tolerate OM positioning. After three trials, the surgeon decided to insert IABP and continue the operation and grafting smoothly.

Intraoperative pacemaker use was done in one case (0.5%). This patient had near total occlusion of RCA and perioperative myocardial infarction. He had severe arrhythmia, and after DC, he got severe bradycardia corrected with a pacemaker, and the rate came sinus after PDA grafting. No intraoperative mortality was reported.

Postoperative re-exploration for bleeding occurred in 2 cases (1%). In the first case, there was no definite cause for bleeding and the second patient had a RIMA branch with no clip on it.

One case (0.5%) was immediately re-explored as the patient got sudden arrest during skin closure. CPR was done, and the heart regained contractility with high support and elevated ST segment in the anterior leads. Vein grafting on LAD was done, and the condition was completely settled.

Postoperative new ischemic changes during ICU stay were not present in any case (0%). Postoperative need for dialysis occurred in 3 patients (1.5%). Two patients were on chronic dialysis preoperative, and the third one had preoperative creatinine of 3 mg/dl.

No patient had a postoperative stroke. Postoperative sternal dehiscence or deep infection occurred in 2 cases (1%). Both patients showed aggressive deep sternal wound infection, and aggressive debridement and re-closure were done over both mediastinal and subcutaneous drains. Both patients had poorly controlled diabetics and old age.

Redo surgery was required in one patient (0.5%) during three months with closed RIMA graft to PDA and inferior MI, so GSV was grafted to PDA to regain perfusion. (Table 2)

Table 2: Early complications in our patients

Complications	N= 200
Conversion to on pump	1 (0.05%)
Intraoperative mortality	0
Redo surgery	1 (0.05%)
Postoperative stroke	0
New ischemic changes by ECG	0
Intra-aortic balloon pump	1 (0.5%)
Re-exploration for bleeding	2 (1%)
Sternal dehiscence or deep infection	2 (1%)
Pacemaker use	1 (0.5%)
Use of vein grafts extension	2 (1%)
Use of complete vein grafts	3 (1.5%)

Discussion

Coronary artery bypass grafting (CABG) remains the most common cardiac surgical procedure performed worldwide, representing an annual volume of approximately 200,000 isolated cases in the US and an average incidence rate of

62 per 100,000 inhabitants in Western European countries [5].

The current rate of multiple arterial grafts performed in the United States remains extremely low: only 10% of patients undergoing CABG receive a second arterial conduit, about 5% RITA, and 5% radial artery grafts [6].

Remarkably, Tranbaugh and coworkers demonstrated that doubling the current 10% rate of total arterial revascularization would save more than 1400 lives each year and that reaching an 80% rate of total arterial revascularization would save more than 10,000 lives annually [7]. On a cumulative person-years perspective, this would imply more than 9000 person-years and 64,000 person-years of life being added, respectively. In the same study, they also reported survival data on the usage of the radial artery instead of the great saphenous vein as a second conduit, finding a significantly increased estimated 10-year survival in patients receiving LITA-RA grafts vs. LIMA-saphenous vein (83.1% vs. 75.7%; $P < .001$) [7].

The development of cardiac stabilizers in the late 1990s allowed the widespread application of the alternative technique of coronary revascularization that does not require CPB [8]. Many studies reported reduced operative morbidity with off-pump CABG relative to on-pump CABG. Off-pump CABG patients had less transfusion requirement, less inotropic support, shorter ventilation time, lower stroke rate, lower incidence of acute kidney injury, and shorter intensive care unit stay [8].

Routine patients may achieve an excellent outcome irrespective of the type of procedure; however, it was thought that off-pump CABG gave substantial benefit to high-risk and elderly patients [8].

In India, off-pump CABG surgery is performed in more than 60% of patients undergoing CABG, mainly because of shorter operative time and reduced procedure cost. However, there is a paucity of published data on the outcomes of off-pump CABG in Indian patients [9]

As compared to data collected from a study conducted on 503,409 patients undergoing isolated CABG in the US from 1997 to 1999 [10]: the renal failure incidence postoperative was 2.4%, while in our study, it was only 1.5% and in patients with preoperative renal problems, mostly this is due to the use of an off-pump technique which prevents the hazardous effect of the heart-lung machine on the renal system. This makes the off-pump technique superior regarding renal function preservation, especially for patients with borderline renal function.

Many studies examining the association between pump use and postoperative renal function have been inconclusive [9]. The ROOBY trial, which remains the largest randomized comparison of off-pump versus on-pump CABG, did not show a benefit of off-pump CABG for postoperative renal function; however, <8% of the patients enrolled in this study had pre-existing CKD. In one dedicated assessment of pump use among patients with preoperative CKD, Sajja and associates observed an association between off-pump CABG and improved renal outcomes [9].

Also, the need for IABP was 1.78%, while in our study, it was 0.5%. This removes the false belief for most surgeons that using CBP decreases the need for intraoperative use of IABP.

The incidence of an early redo-operation during the 1st three months was 1.7%, while in our study, it was 0.5%, which means the off-pump technique does not affect the quality of grafts, at least in the short term.

In comparison with data collected from a study conducted on 290 patients undergoing isolated on-pump CABG from January 2013 to December 2014 [11], the incidence of renal failure in cases that require dialysis was 2% with all patients had adequate preoperative renal function, while in our study it was only in 1.5 % of patients (3 patients) with two patients of them was already on chronic dialysis preoperative. The third patient has impaired renal function preoperative, creatinine 3 mg/dl. In all other patients in our study whose

renal function was adequate preoperative, none developed renal failure and needed dialysis.

In a study of 5598 consecutive patients who received isolated on-pump CABG surgery at Montreal Heart Institute (MHI) [12], early graft failure was documented in 32 patients (0.57%). In contrast, in our study, it was documented in 0.5% of patients.

In a study performed on 2,898 consecutive patients undergoing on-pump coronary artery bypass grafting [13], the incidence of re-exploration for bleeding was 3.1% (89 patients), while in our study, it was only 1% (2 cases). This may be related to the effect of cardiopulmonary bypass in increasing postoperative bleeding.

Despite its survival benefits, bilateral internal thoracic artery (BITA) grafting is not commonly utilized due to concerns over deep sternal wound infection (DSWI). In a study investigated the early outcome of BITA grafting and analyzed the risk of DSWI using a Japanese national database (the Japan Adult Cardiovascular Surgery Database). Data from 560 hospitals were used, and BITA was harvested in 14,249 patients, corresponding to 32.6% of isolated coronary artery bypass cases [14]. DSWI was defined as a wound infection requiring surgical intervention and/or the administration of antibiotics. Multiple logistic regression analysis was employed to model the risk of DSWI. The incidence of DSWI was 1.6 (234 patients), while in our study, it was 1% (2 patients) also using bilateral internal mammary revascularization.

In comparison to a study conducted on 1644 patients in the USA undergo off-pump CABG from 2000 to 2002 [13], the incidence of conversion intraoperative to on-pump technique was 3.7% (61 patients), while in our study, it was 0.5% (1 patient). This may be related to a large number of cases and the high experience of surgery and anesthesia teams in the off-pump technique.

Study limitations

The study has several limitations. All data are from only one cardiac surgery center, and the study reported the short-term results only.

Conclusion

Off-pump total arterial revascularization technique using bilateral internal mammary arteries could have an acceptable early outcome, including conversion to on-pump CABG, stroke, bleeding, and mortality.

Conflict of interest: Authors declare no conflict of interest.

References

1. Lloyd-Jones D, Adams RJ, Brown TM, et al. Heart disease and stroke statistics-2010 update: A report from the American Heart Association. Circulation 2010; 121 (7): e46-e215.
2. Kirklin JW, DuShane JW, Patrick RT, et al. Intracardiac surgery with the aid of a mechanical pump-oxygenator system (Gibbon type): Report of eight cases. Mayo Clin Proc 1955; 30:201
3. Cooley DA, Henly WS, Amad KH, Chapman DW. Ventricular aneurysm following myocardial infarction: Results of surgical treatment. Ann Surg ,1959; 150:595.
4. Albert A, Peck EA, Wouters P, et al. Performance analysis of interactive multimodal CME retraining on attitude toward and application of OPCAB. f Thorac Cardiovasc Surg. 2006; 131 (1): 14-15.
5. Fiore AC, Nauen heim KS, Bride MC. Fifteen year follow up for double internal thoracic artery grafts. Eur J cardiothoracic surg. 1991; 5: 248-252.
6. Shroyer AL, Grover FL, Hattler B, et al. On-pump versus off-pump coronary-artery bypass surgery. N Engl J Med. 2009; 361: 1827–1837.
7. Tranbaugh RF, Lucido DJ, Dimitrova KR, et al. Multiple arterial bypass grafting should be routine. JTCVS. 2015; 150 (6): 1537- 1544.
8. Meharwal ZS, Mishra YK, Kohli V, Bapna R, Singh S, Trehan N. Off-pump multivessel coronary artery surgery in high-risk patients. Ann Thorac Surg. 2002; 74: S1353–S1357.
9. Sajja LR, Mannam G, Chakravarthi RM, et al. Coronary artery bypass grafting with or without cardiopulmonary bypass in patients with preoperative non-dialysis dependent

renal insufficiency: A randomized study. J Thorac Cardiovasc Surg 2007, 133: 378–388.
10. Shroyer AL, Coombs LP, Peterson ED, et al. The Society of Thoracic Surgeons: 30-day operative mortality and morbidity risk models. Ann Thorac Surg. 2003; 75: 1856.
11. Karthik S, Grayson AD, McCarron EE, et al. Reexploration for bleeding after coronary artery bypass surgery: risk factors, outcomes, and the effect of time delay, Ann Thorac Surgery. 2004; 78 (2): 527-534.
12. Ohira S, Miyata H, Yamazaki S, et al. Deep sternal wound infection after bilateral internal thoracic artery grafting: Insights from a Japanese national database, The Journal of Thoracic and Cardiovascular Surgery. 2019; 157(1): 166-173.
13. Edgerton JR, Dewey TM, Magee MJ, et al. Conversion in off-pump coronary artery bypass grafting: an analysis of predictors and outcomes. Ann Thorac Surg. 2003; 76 (4): 1138-42.
14. Boulton BJ, Kilgo P, Guyton RA, et al. Impact of preoperative renal dysfunction in patients undergoing off-pump versus on-pump coronary artery bypass. Ann Thorac Surg. 2011; 92: 595–601.