

Multimodality Targeted Approach in Redo Off-Pump Coronary Artery Bypass Surgery

Yugal K Mishra, PhD, Harpreet Wasir, MCh, Surendra N Khanna, MCh, Sameer Shrivastava, DM¹, Yatin Mehta, MD², Naresh Trehan, MD

Department of Cardiovascular Surgery

¹Department of Cardiology

²Department of Anaesthesiology

Escorts Heart Institute and Research Centre

New Delhi, India

ABSTRACT

Records of 86 patients who underwent off-pump redo coronary revascularization between December 1997 and December 2000, were analyzed. Approaches included median sternotomy (47), anterolateral thoracotomy for left anterior descending artery and diagonal targets (35), posterolateral thoracotomy for the obtuse marginal with proximal anastomosis on descending aorta (3), and a combined subxiphoid-anterior thoracotomy approach (1) for right gastroepiploic artery-to-left anterior descending artery anastomosis. The mean age was 61.82 years. There were 2 (2.3%) operative deaths. Complications included perioperative myocardial infarction in 4 patients and reexploration for bleeding in one. Blood transfusion was required in 12 patients. The mean length of hospital stay was 5 ± 2 days. A multimodality targeted approach for off-pump redo coronary artery bypass offers a less invasive but safer method of myocardial revascularization, with decreased complications, lower blood product requirement, and early hospital discharge.

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INTRODUCTION

With increasing numbers of patients who have undergone coronary artery bypass grafting (CABG), the incidence of repeat CABG is rising. Reoperative procedures have certain technical difficulties: problems with reentry, potential for cardiac and conduit injury during dissection, availability of conduit, management of patent vein grafts, myocardial protection, and bleeding and blood product use.¹ As experience of redo CABG has increased, alternative strategies have evolved to lower the operative risks which exceed those of the initial revascularization.² Such strategies include alternative techniques for reentry, strict avoidance of graft manipulation to minimize the risk of graft atheroembolism, and modification of the method of myocardial protection, depending on the status of the native coronary circulation and the patency of venous or arterial grafts. As an alternative method of myocardial

protection and to obviate the inherent risks of cardiopulmonary bypass (CPB), we carried out redo CABG without CPB in a carefully selected group of patients.^{3,4} Our experience was reviewed to determine whether the off-pump technique using individually tailored approaches facilitated redo CABG and decreased morbidity and mortality.

PATIENTS AND METHODS

From December 1997 to December 2000, 86 patients underwent reoperative CABG without CPB in our institute. The surgical results (mortality, morbidity, and intensive care unit and hospital stay) were evaluated retrospectively. During the same time frame, 170 patients underwent conventional on-pump redo CABG. Patient data for the study group are summarized in Table 1. Target sites were the left anterior descending artery (LAD) in 62, a

For reprint information contact:

Yugal K Mishra, PhD Tel: 91 11 682 5000 Fax: 91 11 682 5013 email: dryugal@mantramail.com

Department of Cardiovascular Surgery, Escorts Heart Institute and Research Centre, Okhla Road, New Delhi 110025, India.

Table 1. Baseline Clinical Characteristics of 86 Patients

Variable	No. of Patients
Male/female	77/9
Mean age (years)	61.82 ± 8.04
Unstable angina	34
Congestive heart failure	3
Previous myocardial infarction	35
Hypertension	38
Non-insulin-dependent DM	32
Previous CVA	2
Peripheral vascular disease	4

CVA = cerebrovascular accident, DM = diabetes mellitus.

Table 2. Angiographic Profile of 86 Patients

Variable	No. of Patients
Aortic atheroma	6
Triple-vessel disease	74
Double-vessel disease	12
Stenosed or occluded LAD graft	77
Patent LAD graft	6
Disease in LAD beyond previous graft	3
Patent OM and PDA grafts	22
Disease in OM & PDA beyond graft	12
Left ventricular ejection fraction (%)	40.0 ± 7.2

LAD = left anterior descending artery, OM = obtuse marginal, PDA = posterior descending artery.

previously placed saphenous vein graft (SVG) on the LAD in 1, ramus intermedius in 4, right coronary artery in 37, and obtuse marginal (OM) in 26 patients. Table 2 shows the angiographic profile of these patients. The various approaches and strategies used to carry out minimally invasive redo CABG are listed in Table 3. All patients were monitored with a radial arterial line, central venous and pulmonary arterial catheters, and transesophageal echocardiography.

In the 47 patients undergoing reoperation through a median sternotomy, standard techniques were used for sternal reentry. The heart and ascending aorta were dissected free of adhesions to the extent required for satisfactory exposure. A second surgical team harvested an appropriate length of saphenous vein or radial artery. When internal mammary artery was to be used, it was prepared after lysis of adhesions. After systemic heparinization (2 mg·kg⁻¹), the proximal saphenous vein or radial artery anastomosis to the aorta was constructed with a running 6/0 Prolene suture (Ethicon, Somerville, NJ, USA) under partial aortic occlusion. When grafting the LAD, exposure was obtained by elevating the heart on a laparotomy pad and observing the hemodynamic response. Mild hypotension was corrected easily with volume or vasopressor administration, usually epinephrine or norepinephrine. For segmental stabilization, an Octopus stabilizer (Medtronic Inc., Minneapolis, MN, USA) was applied to the myocardium adjoining the target area. Intracoronary shunts

Table 3. Surgical Procedures in 86 Patients

Variable	No. of Patients
Median sternotomy	47
Left anterior minithoracotomy	35
Posterolateral thoracotomy	3
Combined approach	1
Preoperative IABP	3
Single-vessel CABG	54
Double-vessel CABG	20
Triple-vessel CABG	12
MIDCAB + TMLR	4
MIDCAB + PTCA	4

CABG = coronary artery bypass grafting, IABP = intraaortic balloon pump, PTCA = percutaneous transluminal coronary angioplasty, MIDCAB = minimally invasive direct coronary artery bypass, TMLR = transmyocardial laser revascularization.

were used to minimize myocardial ischemia.

In 35 patients who had either a patent graft or distal targets in the circumflex and posterior descending artery territory unsuitable for grafting, the left internal mammary artery (LIMA) was used to bypass the LAD or ramus intermedius by minimally invasive direct coronary artery bypass (MIDCAB) surgery. A 4th (occasionally, 5th) intercostal incision was made, beginning 2 to 3 cm lateral to the sternal border on the left side. The pleural cavity was entered and the lung was packed out of the field. Before harvesting the LIMA, a standard small thoracic retractor was positioned, the pericardium was identified and incised, and the LAD or ramus intermedius was located. After ascertaining the feasibility, the procedure was continued using the MIDCAB system (Cardiothoracic Systems, Inc., Cupertino, CA, USA) which consists of two retractors and a regional cardiac wall stabilizer. With the help of the LIMA retractor, an adequate length of LIMA was harvested, and LIMA-to-LAD or ramus intermedius anastomosis was performed after systemic heparinization (1.5 mg·kg⁻¹). In one patient, LIMA was grafted on a previously placed SVG to the LAD, which was blocked proximally but the distal anastomosis was patent and the distal LAD was small and intramyocardial. In 4 patients who had a blocked SVG to the circumflex territory, percutaneous transluminal coronary angioplasty (PTCA) of OM branches was carried out 5 days after the MIDCAB procedure, to achieve complete myocardial revascularization. In another 4 patients, transmyocardial laser revascularization (TMLR) was used in the circumflex and posterior descending artery territory along with MIDCAB because there were no suitable distal targets for either CABG or PTCA. All territories subjected to TMLR were viable based on preoperative stress thallium or dobutamine echocardiographic studies. Any area that showed scarring or in which the viability was in doubt was excluded from all interventions.

Three patients had patent LIMA-to-LAD grafts but the

Table 4. Operative Outcome in 86 Patients

Variable	No. of Patients
Perioperative myocardial infarction	4 (4.7%)
Cerebrovascular accident	0 (0%)
Reoperation for bleeding	1 (1.2%)
New onset atrial fibrillation	2 (2.3%)
Blood transfusion	12 (14%)
Recovery room stay (hours)	22 ± 7
Hospital stay (days)	5 ± 2
Patency of anastomosis on Doppler flow	35/35 (100%)
Patency of anastomosis on angiogram	17/17 (100%)
Mortality	2 (2.3%)

SVG to OM was blocked, hence they underwent off-pump OM grafting using a local immobilization technique via a posterolateral thoracotomy approach; inflow was from the descending aorta. Following double-lumen endobronchial intubation, the patients were placed in the right lateral decubitus position with the pelvis rotated to permit femorofemoral CPB if the need arose. A posterolateral thoracotomy was performed in the 5th intercostal space. The pericardium was opened posterior to the phrenic nerve, and adhesions were taken down along the OM distribution. Dissection of posterior mediastinal adhesions was carried out to expose the descending aorta in the region of the inferior pulmonary ligament, which was thoroughly mobilized. The Octopus device was used for local myocardial stabilization during distal anastomosis. Proximal anastomosis was performed in the descending thoracic aorta using a partial occluding clamp. In one patient, a LIMA-to-diagonal branch and SVG to the OM were patent but a SVG to the LAD was occluded, hence a combined approach was used to carry out LAD grafting without a sternotomy. The right gastroepiploic artery was harvested through the subxiphoid approach and a left anterior minithoracotomy was performed to expose the LAD. The right gastroepiploic artery was rerouted transdiaphragmatically and grafted retrogradely to the distal LAD.

Intraoperative LIMA graft patency was assessed by Doppler flow measurements in patients who underwent MIDCAB procedures. Short-term graft patency in 17 redo cases was evaluated by angiography on the 5th postoperative day.

RESULTS

There were 2 hospital deaths (2.3%). One death was due to pulmonary embolism, the other was caused by low cardiac output syndrome after MIDCAB; this patient was already in congestive heart failure and was put on intraaortic balloon pump support after failed PTCA of a diseased SVG to the LAD. The operative outcomes are listed in Table 4. The 12 patients who required blood transfusion received an average of 1.2 units per patient.

There was no deep chest wound problem. Of the 17 patients who consented to postoperative angiography, all had adequately functioning redo grafts; 4 who had stenosed OM vein grafts underwent PTCA for a diseased SVG to the circumflex artery.

DISCUSSION

Redo CABG is increasing, with excellent results reported.^{5,6} Although the mortality associated with redo operations has decreased, it remains significant, particularly in the more complex cases.^{7,8} Economic forces aimed at decreasing morbidity have intensified in all surgical fields, with the focus on less invasive techniques tailored to the individual patient. A reduction in morbidity after cardiac operations depends primarily on avoiding the detrimental effects of CPB, rather than simply creating smaller access incisions. Redo CABG without CPB reduces operative time and postoperative hospital stay, which translates into a reduction of hospital costs. There are fewer bleeding complications with these techniques; only 14% of patients in this series required blood transfusion, and only one was reexplored for bleeding. Although construction of distal anastomoses on a beating heart is technically more demanding and requires a short period of coronary occlusion, the low incidence of perioperative myocardial infarction and absence of cerebrovascular accident in this series reinforces the choice of the off-pump technique for redo surgery.

For redo CABG, the MIDCAB procedure avoids manipulation of patent grafts and mobilization of adhesions from the previous operation. Favorable results of this procedure for repeat grafting of the LAD using LIMA have been reported.^{9,10} In all 35 cases we treated by MIDCAB, an adequate length of LIMA could be dissected with the aid of the LIMA retractor. The LIMA was grafted to the LAD distal to a previous SVG in 30 cases, to an in-situ SVG in 1 case, and to ramus intermedius branches in 4 cases. One patient with a patent LIMA-to-diagonal branch graft and a blocked SVG to the LAD required a combined left anterior minithoracotomy and subxiphoid approach. This avoided redo sternotomy and the risk of injury to the patent graft. The combined MIDCAB and PTCA in 4 patients was considered a safe alternative for high-risk cases, allowing complete revascularization without a redo sternotomy or CPB. In 4 MIDCAB patients with no suitable targets for CABG or PTCA, LIMA-to-LAD anastomosis was combined with TMLR. Thus, complete revascularization could be achieved even though surgical intervention was not possible in some areas, as shown in other studies.¹¹

The technique of off-pump OM revascularization was combined successfully with the thoracotomy route for redo CABG by Baumgartner and colleagues.¹² In this series, we used a posterolateral left thoracotomy in 3 patients to

bypass OM branches without CPB. This method was safe and effective in each case, and we believe that off-pump OM grafting by the thoracotomy approach is a useful adjunct in redo CABG, particularly for patients with patent LIMA grafts.

The introduction of off-pump CABG extends the benefits of coronary revascularization to patients who would otherwise be considered high risk for redo surgery. Although long-term data on graft patency is need, this multimodality targeted approach offers a safe and less invasive method of myocardial revascularization, with acceptable morbidity and mortality, a low requirement for blood and blood products, and early hospital discharge.

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