The Heart Surgery Forum #2003-60302
6 (6), 2003

Online address: www.hsforum.com/vol6/issue6/2003-60302.html

Dysfunction of Left Ventricle as an Indication for Off-Pump Coronary Artery Bypass Grafting

(#2003-60302 . . . April 29, 2003)

Dr. Jasinski

Marek J. Jasinski, MD, FETCS,[1] Stanislaw Wos, MD, PhD,[1] Piotr Olszówka, MD,[1] Adam Szafranek, MD,[1] Ryszard Bachowski, MD,[1] Wojciech Ceglarek,[1] Kazimierz Widenka, MD,[1] Marek Gemel, MD,[1] Marek Deja, MD,[1] Dariusz Szurlej, MD[2]

[1]2nd Department of Cardiac Surgery, [2]Department of Cardiothoracic Anesthesia and Intensive Care, Medical University of Silesia, Katowice, Poland

ABSTRACT

Background: Coronary artery bypass grafting (CABG) with cardiopulmonary bypass carries significant risk for patients with severe left ventricular (LV) dysfunction.

Methods: Between 1997 and 2000, 240 patients underwent OPCAB. The patients were retrospectively divided into 2 groups with regard to LV function. Group 1 consisted of 90 patients with ejection fraction (EF) <35% and group 2 of 150 patients without severe LV impairment and EF >35%. Patients were compared for preoperative risk factors, perioperative mortality, and postoperative complications.

Results: Preoperative expected mortality according to EuroSCORE was higher in group 1, 5.95, compared with group 2, 2.66 (P = .0005). A few preoperative risk factors were more common in group 1: urgent operation (P = .00001), unstable angina (P = .0018), Canadian Cardiovascular Society class (P = .001), myocardial infarction (P = .0001), and peripheral arteriopathy (P = .0006). Mean number of grafts was 1.51 in group 1 and 1.55 in group 2 with the same internal thoracic artery utilization. Perioperative drainage, anesthesia and intubation time, transfusion rate, and use of inotropes were comparable. Actual, nonadjusted mortality was 2.5% in group 1 and 1.4% in group 2 (P = not significant). Overall rates of postoperative complications were comparable; only use of an intraoperative balloon pump was more frequent in group 1 (P = .006). Postoperative stay was shorter in group 1 (P = .007).

Conclusions: Off-pump CABG for patients with LV impairment is associated with surgical outcome similar to that among patients with normal LV function, in spite of the presence of unfavorable risk factors. Off-pump surgery with selective anterior (including right main) arterial revascularization can be indicated in the presence of poor LV function.

Presented at the Fifth Annual Meeting of the International Society for Minimally Invasive Cardiac Surgery, New York, New York, USA, June 21-24, 2002.

Received April 9, 2003; received in revised form April 19, 2003; accepted April 29, 2003.

Address correspondence and reprint requests to: Marek Jasinski, MD, FETCS, Debowa 23, 41500 Chorzów, Poland; 0048-601166716 (e-mail: Marekjas@hotmail.com).

INTRODUCTION

Coronary artery bypass grafting (CABG) with cardiopulmonary bypass (CPB) carries significant risk for patients with severe left ventricular (LV) dysfunction. Currently used scoring systems account for LV dysfunction as a severe risk factor [Christakis 1992, O'Connor 1992]. On the basis of American Society of Thoracic Surgeons (STS) score, it has been proved that CPB is an independent risk factor for patients with a predicted mortality of 10% and more [Arom 2000]. The purpose of this study was to evaluate results of CABG without CPB (OPCAB) with regard to presence of impairment of LV function. The purpose of this analysis was to enable us to determine whether poor LV function is a risk factor in OPCAB, as it has been proved it is in routine operations with CPB [Christakis 1992, O'Connor 1992].

METHODS

Between 1997 and 2000, 240 patients underwent OPCAB. The patients were retrospectively divided into 2 groups with regard to LV function. Group 1 consisted of 90 patients with ejection fraction (EF) <35% and group 2 of 150 patients without severe LV impairment and EF >35%. Patients were compared for preoperative risk factors, perioperative mortality, and postoperative complications.

A specific perioperative protocol was established for performance of OPCAB (off-pump CABG).

Exposure was achieved by means of pericardial traction sutures used to pull the heart within the pericardium and to minimize displacement. The traction stitches were located above the left superior pulmonary vein (LSPV), between the LSPV and the diaphragm, and between the LSPV and the inferior vena cava. Epicardial stabilization was achieved with an Octopus 2 device (Medtronic, Minneapolis, MN, USA). Verticalization of the heart was achieved with minimal hemodynamic instability. To achieve hemodynamic

Table 1. Preoperative Patient Profiles*

Parameter	Group 1 (EF ≤35%; n = 90)	Group 2 (EF >35%; n = 150)	Significance, *P*
Sex			NS
Male	73	111	
Female	17	39	
Angina status			<.0018
CCS 1	0	1	
CCS 2	19	73	
CCS 3	42	59	
CCS 4	29	17	
Symptom status			<.0018
Stable	28	22	
Unstable	62	128	
Left anterior coronary artery disease	90	150	NS
Right coronary artery disease	41	63	NS
Circumflex artery disease	19	27	NS
Previous myocardial infarction	68	74	<.00001
Previous cardiologic intervention	7	12	NS
Previous coronary artery bypass graft	3	4	NS
Diabetes	14	27	NS
Arterial hypertension	46	79	NS
Renal insufficiency	4	9	NS
Cerebrovascular disease	6	6	NS
Peripheral vascular disease	22	12	<.00001
LM genotype	3	5	NS
Morbid obesity (body mass index >30)	13	21	NS
Operative priority			<.00001
Elective	64	133	
Urgent	26	17	
Age	56.58 ± 9.9	55.46 ± 8.66	NS
EuroSCORE	5.95 ± 2.4	2.66 ± 2.25	<.0005
Height	169.68 ± 7.52	168.92 ± 7.89	NS
Weight	78.31 ± 11.58	77.87 ± 11.91	NS

*Data shown as median ± SD. EF indicates ejection fraction; NS, not significant; CCS, Canadian Cardiovascular Society.

stabilization, a combination of Trendelenburg position, fluid transfusion to compensate for preload decrease, and administration of inotropes to increase coronary flow and stroke volume was used.

Preoperative planning was essential for minimizing regional ischemia and maintaining optimal hemodynamics. Left anterior descending artery (LAD) reperfusion was established at the beginning of revascularization. Preconditioning was not routinely performed; however, when subcritical occlusion was present, 3 minutes of preconditioning was followed by 3 minutes of reperfusion. This procedure enabled us to evaluate tolerance of ischemia. Shunting allowed for continuous perfusion. The anticoagulation protocol consisted of heparin given as a half-dose regimen: 1.5 mg/kg and only half of that dose reversed with protamine. Early postoperatively 150 mg of aspirin was given through a nasogastric tube.

Statistical analysis was performed with 2-way Fisher exact test and unpaired Student test when appropriate, with $P < .05$ considered statistically significant.

RESULTS

Analysis of OPCAB patients with regard to preoperative EF showed that expected mortality according to EuroSCORE was higher in group 1, 5.95, compared with group 2, 2.66, $P = .0005$. A few preoperative risk factors were more common in group 1: urgent operation ($P = .00001$), unstable angina ($P = .0018$), Canadian Cardiovascular Society class ($P = .001$), myocardial infarction ($P = .0001$), and peripheral arteriopathy ($P = .0006$) (Table 1). The majority of patients had 1- or 2-vessel disease, defined as cross-sectional stenosis of at least 75%. Distributions of 1-, 2-, and 3-vessel revascularization were comparable; however, revascularization of the circumflex artery territory was less frequent in group 1 (Table 2). The mean number of grafts was 1.51 in group 1 and 1.55 in group 2 with the same internal thoracic artery utilization (Table 2). Perioperative drainage, anesthesia and intubation time, number of transfusions, and use of inotropes were comparable (Table 3). Actual, unadjusted mortality was 2.4% in group 1 and 1.4% in group 2 (P = not significant).

Table 2. Clinical Outcome*

Parameter	Group 1 (EF ≤35%; n = 90), mean ± SD	Group 2 (EF >35%; n = 150), mean ± SD	*P*
Total number of grafts	1.51 ± 0.6	1.55 ± 0.62	NS
Internal thoracic artery	84	142	NS
Theater time, h	2.4 ± 0.54	2.35 ± 0.53	NS
Intraaortic balloon pump	10	3	<.006
Postoperative ventilation, h	10.89 ± 9.05	11.39 ± 5.25	NS
Total drainage, mL	503.55 ± 215.16	512.24 ± 236.99	NS
Mortality, no. of deaths	2	2	NS

*EF indicates ejection fraction; NS, not significant.

Overall postoperative complications were comparable. Only use of an intraaortic balloon pump was more frequent in group 1 ($P = .006$) (Table 3). Postoperative stay was shorter in group 1 ($P = .007$) (Table 3).

DISCUSSION

According to the results of our study, coronary revascularization without CPB performed on patients with impaired LV function may be associated with very low mortality and insignificant morbidity, in spite of unfavorable risk stratification owing to frequency of comorbidity and clinical preoperative condition. These results are in accordance with those in other reports [Pfister 1992, Moshkowitz 1997]. Only slightly higher use of an intraaortic balloon pump (IABP) was noticed, and that was partially related to higher preoperative use of an IABP, an approach that is recommended [Moshkowitz 1997, Arom 2000]. Preoperative placement of an IABP helps in safe heart luxation or manipulation, especially in cases of low EF [Moshkowitz 1997, Arom 2000]. The paradoxic phenomenon that length of hospitalization was shorter for patients with impaired LV function may be the result of a well-planned approach and selection. More than 90% of patients were discharged from the intensive care unit within 24 hours, and that factor influences total hospital stay and hospital costs [Dell-Rizzo 1998]. The above-mentioned low mortality and morbidity may have been caused by several factors. CPB activates various inflammatory mediators, including tumor necrosis factor, a well-known causative factor for myocardial depression [Brasil 1998]. Adverse influence of inflammatory mediators may be poorly tolerated by already depressed myocardium. This condition may lead to severe heart failure, certainly after prolonged CPB [Christakis 1992, Kirklin 1993]. In our study inotropes were used with the same frequency regardless of preoperative systolic function. An additional factor contributing to LV depression after on-pump CABG is related to paradoxical septal movement regardless of myocardial protection technique used. This factor may play a fundamental role in a poorly contracting heart [Akins 1984]. Better flow achieved from grafts, especially internal mammary (internal thoracic) artery grafts, because of lower coronary resistance and lack of myocardial edema may improve myocardial performance when operations are performed without CPB.

As far as revascularization strategy is concerned, the majority of patients had 1 or 2 grafts performed because preselection

Table 3. Clinical Outcome*

Parameter	Group 1 (EF ≤35%; n = 90)	Group 2 (EF >35%; n = 150)	*P*
Number of distal coronary anastomoses			NS
1	49	77	
2	36	63	
3	5	10	
Left anterior descending coronary artery	90	150	NS
Right coronary artery	40	42	NS
Circumflex artery	6	21	<.05
Postoperative complications	14	14	NS
Postoperative inotropes	15	14	NS
Postoperative blood use	29	46	NS
Pulmonary complications	12	9	NS
Conversion to cardiopulmonary bypass	3	1	NS
Intensive care unit discharge within 24 h	83 (92%)	141 (94%)	NS
Total hospital stay, d	9.5 ± 3.46	10.86 ± 3.86	<.007

*EF indicates ejection fraction; NS, not significant.

criteria for OPCAB give preference to 1- or 2-vessel coronary artery disease. In spite of this factor, patients with EF <35% underwent circumflex territory revascularization less frequently. Six of 19 patients in group 1 who had circumflex artery disease underwent revascularization of this territory. In group 2, 21 out of a total of 27 patients who had circumflex disease. Several factors may have contributed to the lower number of grafts in patients with impaired function. One such factor was presence of nongraftable territories owing to previous infarcts. In our study, the majority (75%) of patients with impaired LV function had at least 1 transmural myocardial infarction. Among those 19 patients, in 6 (33%) of those cases, the circumflex artery was not graftable, and in 3 (12%) revascularization was abandoned because of comorbid conditions. A hybrid procedure may be a valid alternative OPCAB for grafting anterior vessels (LAD, RCA); the circumflex territory is left for cardiologic intervention [Moshkowitz 1997]. In our study 4 patients with suitable circumflex artery lesions underwent successful percutaneous transluminal coronary angioplasty after CABG. As a result of this approach, only 3 patients (3.3%) may be considered to have incomplete revascularization.

Significant dilatation of the left ventricle coexisting with poor function may cause major changes in hemodynamics during verticalization. Therefore CPB may be indicated for patients who have 3 or more graftable vessels, including vessels from the back of the heart, if there is particular risk of instability during verticalization owing to heart enlargement and poor contraction. In our study only 3 (3.3%) of the patients in group 1 and only 1 (0.75%) of the patients in group 2 needed conversion. Arom and colleagues had good results with multivessel OPCAB on patients with impaired LV function [Arom 2000]. However, they defined hypertrophied dilated heart as a relative contraindication to OPCAB when the posterolateral wall is considered for revascularization. As a result, the majority of patients with poor function are still operated on with CPB support, including patients presenting with mitral regurgitation when surgical correction is a predictor of favorable long-term outcome [Boling 1998]. On the other hand, those results may represent relatively historical cohorts of patients who underwent operations before the introduction of apical suction devices, which allow for easier manipulation of enlarged, poorly contracting hearts. Arterial revascularization was performed on 93% of the patients with impaired LV function. Very high utilization of internal thoracic arteries may have contributed to the good results. There is evidence that the internal mammary artery should be considered the graft of choice regardless of LV function. Use of this artery has been proved an important predictor of long-term results after CABG [Loop 1986].

CONCLUSIONS

Results of OPCAB for patients with LV impairment are very satisfactory. OPCAB for patients with LV impairment is associated with surgical outcome similar to that among patients with normal LV function, in spite of unfavorable preoperative risk factors. Off-pump surgery with selective anterior (including right main) arterial revascularization can be performed in the presence of poor LV function.

REFERENCES

Akins CW, Bouchar C, Pohost G. 1984. Preservation of IVS function in patients having CABG without CPB. Tex Heart Inst J 11:52-7.

Arom KV, Flavin TF, Emery RW, Kshettry VR, Petersen RJ, Janey PA. 2000. Is low ejection fraction safe for off-pump coronary bypass operation? Ann Thorac Surg 70:1021-5.

Bolling S, Pagani F, Deeb G, et al. 1998. Intermediate-term outcome of mitral reconstruction in cardiomyopathy. J Thorac Cardiovasc Surg 115:381-8.

Brasil L, Gomes W, Salomao R, et al. 1998. Inflammatory response after myocardial revascularization with or without CPB. Ann Thorac Surg 66:56-60.

Christakis GT, Weisel RD, Fremes SE, et al. 1992. CABG in patients with poor ventricular function. J Thorac Cardiovasc Surg 103:1083-92.

Dell-Rizzo, Boyd D, Novick R, et al. 1998. Safety and cost-effectiveness of MIDCABG in high risk CABG. Ann Thorac Surg 66:1002-7.

Kirklin JW, Barratt-Boys BG. 1993. Cardiac Surgery, 2nd ed. New York: Churchill Livingstone. p 83-97.

Loop F, Lytle B, Cosgrove DM, et al. 1986. Influence of the internal mammary artery graft on 10 years survival and other cardiac events. N Engl J Med 314:1-6.

Moshkowitz Y, Sternik L, Paz Y, et al. 1997. Primary CABG without CPB in impaired LV function. Ann Thorac Surg 63:S44-7.

O'Connor GT, Plume SK, Olmstead EM, et al. 1992. Multivariate prediction of in hospital mortality associated with CABG surgery. Circulation 85:2110-8.

Pfister A, Zaki M, Garcia J. 1992. CABG without CPB. Ann Thorac Surg 54:1085-92.