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Indications, benefits and early outcomes for off-pump coronary artery bypass grafts – a single centre experience

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ABSTRACT

Between January 2011 and December 2012, in Cardiovascular Surgery Clinic from Cluj- Napoca, Romania, we operated 604 patients with coronary revascularisation, of which 342 on-pump and 262 off-pump, from which we selected two groups of 100 patients each, that had undergone initial coronary revascularization without any other reconstructive valvular or arterial procedure, and had been matched by age, sex and preoperative estimation of risk of mortality and complications. Postoperative clinical parameters and outcomes data were analysed, and the variable and total costs for each patient were calculated.

Our survey demonstrated that the off-pump myocardial revascularization is a safe method with a low rate of early complications and early mortality, and has decreased the use of limited and costly resources.

KEYWORDS Coronary artery bypass grafting, off-pump coronary revascularization, low cost coronary artery surgery

Introduction

The extracorporeal circulation – a technique which allows the development of open heart surgery – determines a succession of physiological distresses, which include the activation of inflammatory system, blood cells destruction, neurological disorders etc.

In the last decades the use of less invasive techniques became more important in the therapeutic arsenal of the open-heart surgery. Concerning the coronary surgery, there were developed revascularization techniques on beating heart by carrying out devices used for immobilization of the operative field, that allow the anastomoses to be performed in best conditions.

Theoretically, the coronary surgery on beating heart avoids the occurrence of associated adverse reactions by eliminating the extracorporeal circulation. As a result the patient recovery is much faster and the cost per patient is lower.

The aim of our survey was to evaluate the immediate results and the cost of each type of revascularization with or without extracorporeal circulation.

Patients and Methods

From January 2011 to December 2012, at the Clinic of Cardiovascular Surgery from Cluj-Napoca, Romania, were performed 604 coronary revascularizations, out of which 342 with extracorporeal circulation (on-pump) and 262 without extracorporeal circulation (off-pump). The patients where operated by the same surgical team.

The surgical technique was standard for the patients with extracorporeal circulation: - 32 Celsius degree hypothermia, cannulation to ascending aorta, cold blood cardioplegia 1:1, the distal anastomoseses were performed before the proximal anastomoses. For the patients with off-pump operation we used the cardiac stabilizer Octopus II (Medtronic company, Inc., Fridley, MN), heart exposure was facilitated by pulling wires on the pericardium, and by opening the right pleura to allow the displacement of the heart into the pleural cavity, in the moment of approaching the circumflex artery. Distal anastomoses were performed before the proximal anastomoses and the anastomosis of left internal mammary artery was always performed first.

All patients were subject to the same monitoring and treatment protocol both in the Intensive Care Unit (ICU) and surgical department.

The data was collected prospectively and examined retrospectively, monitoring mainly the preoperative, postoperative and during-the-operation clinical characteristics, such as mechanical ventilation time, number of blood units administrated to each patient, incidence of metabolic acidosis (defined by HCO3 < 21mm/L), maximum level of CPK during the first 24 hours after surgery, overall postoperative length of stay. We also monitored the occurrence of early postoperative complications (atrial fibrillation, re-interventions for bleeding, myocardial infarction), and the early mortality (during the first 30 days). Fixed and variable costs for each patient were calculated. Statistical analyses were performed with SPSS – student t test for Windows.

Results

There were 74% men in the first group (on-pump revascularization) versus 81% men among patients undergoing off-pump coronary revascularization. The mean age was 57. 4 years in the on-pump group, and 54.3 years in the off-pump group. Average ejection fraction was 47.1% for the patients operated on-pump (range between 19 – 67%), and 50.7% for off-pump patients (range between 25 – 69%) (Table 1).

Table 1. Preoperative characteristics of patients who underwent off-pump revascularization compared with those who underwent on-pump coronary artery bypass.

Operative technique	Gender : number of patients	Mean age (years)	Mean ejection fraction (%)
ON-PUMP	Males : 74 Females : 26	57.4 (Range: 30 – 82)	47.1 (Range: 19 – 67)
OFF-PUMP	Males : 81 Females : 19	54.3 (Range: 26 – 76)	50.7 (Range: 25 – 69)

The prevalence of risk factors was similar in both groups (Table 2).

Table 2. Risk factors in patients undergoing on- or off-pump cardiac surgery.

Risk Factor	On-pump surgery (no. of patients)	Off-pump surgery (no. of patients)
Diabetus melitus	23	13
Obesity	11	14
Dislipidemia	40	54
Hypertension	30	33
Peripheral arterial obstructive disease	20	18
Previous myocardial infarction	46	40
Rhythm disorders	0	3
Carotid artery stenose	5	2
Stroke	3	0
Pace maker cardiostimulation	0	1
Cigarette Smoking	68	57
Percutaneous coronary angioplasty	5	7
Serum creatinine > 2.0	6	4

The number of distal anastomoses was higher in the on-pump group of patients (an average of 2.92), reporting to the patients who were operated off-pump (an average of 2.37) (Table 3).

Tabel 3. Number of distal anastomoses in patients undergoing on- or off-pump coronary surgery

Number of distal anastomoses	On-pump (no. of patients)	Off-pump (no. of patients)
1	3	22
2	26	30
3	51	37
4	16	11
5	4	0
Total	100	100
Mean number	2.92	2.37

The significant differences were noticed in the analysis of postoperative clinical parameters (Table 4), such as early postoperative bleeding, the necessary of blood units in the first day, the necessary of inotropic support, the occurrence of the metabolic acidosis. The rhythm disorders occurred on the first two postoperative days on 18 patients operated on-pump, reporting to 10 patients with off-pump surgery. The postoperative time of mechanical ventilation was reduced for the patients with off-pump surgery - 7.5 hours, reporting to 11.1 hours for the patients with on-pump intervention. The postoperative level of CPK – MB as a myocardial infarction (MI) marker was normal in most of the cases both on pump and off-pump, excepting the patients with perioperative MI. In our study there are significant differences regarding the level of the enzymes (CPK) on the first postoperative day, its level being double (1346.7 u/l) on the off-pump patients reporting to the on-pump patients (600.8 u/l). We can not precisely mention if the level of CPK is given by the myocardial ischemia during the surgical intervention, by the operative mechanical traumatism or by other factors. Still, the low level of CPK – MB excludes the myocardial ischemia as a cause of increasing the CPK level.

Complications of the sternal wound (dehiscence) with mediastinitis were also more frequent in the patients operated on-pump - 3 patients, reporting to only one off-pump patient. The major complications were relatively low in both groups, 1 stroke and 3 myocardial infarction on the first postoperative day on patients in the on-pump group, and 2 patients with myocardial infarction in the off-pump group.

The number of hospitalization days was lower (7.6 days) on the patients with off-pump surgery, reporting to 9.2 days on the patients operated on-pump.

Early mortality occurred in 3 patients from the on-pump group, and in 1 patient from the off-pump group.

Table 4. Postoperative characteristics of patients undergoing on- or off-pump coronary artery bypass.

Parameters	On-pump surgery	Off-pump surgery	P
Average Bleeding (ml) / day 1-2 (ml)	735 / (600-1050)	512 (400-820)	0.001
Transfusion (blood units)	180	30	0.0001
Inotrop assistance (no. of patients)	28	9	0.008
Reinterventions for bleeding (no. of patients)	8	3	0.038
Rhythm disorders (no. of patients)	18	23	0.549
CPK level – day 1 (mg/dl)	600,8	1346.7	0.0001
CPK-MB level– day 1 (mg/dl)	37.6	44.9	0.99
Metabolic acidosis (no. of patients)	27	10	0.001
Average Mechanical ventilation (hours)	11.1	7.5	0.99
Stroke (no. of patients)	1	0	-
Acute myocardial infarction - day 1-2 (no. of patients)	3	2	0.367
Sternal dehiscence (no. of patients) With mediastinitis Without mediastinitis	3 1	1 1	0.038
Average Hospitalization (days)	9.2	7.6	0.001
Early mortality (no. of patients)	3	1	0.038

We have wondered how costly is a surgical myocardial revascularization performed with or without extracorporeal circulation. The appraisal made by our financial department shows that an off-pump intervention is about 1000 – 1500 USD, and an on-pump intervention costs between 3000 and 4000 USD; this amounts do not include the cost of hospitalization in the department of cardiology, where there are no differences between the two groups of patients.

Discussion

The major importance of extracorporeal circulation is represented by the fact that it enabled the rising and development of cardiac surgery. But, the use of extracorporeal circulation determines the occurrence of major complications, especially respiratory malfunctioning, activation of the inflammatory sys-

tem, and neurological disorders.

The off-pump surgery has demonstrated that it produce less organic malfunctioning than the on-pump surgery. For instance, glomerular filtration rate was better to the off-pump patients, beside the on-pump patients [1]. The incidence of metabolic acidosis was lower on the patients operated off-pump – this fact being remarked both by us and other authors

[2,3,4] ; similarly the necessary of inotropic

support was lower [1,5] in the off-pump surgery reporting to the on-pump surgery. Although we did not find significant differences between the other parameters, such as rhythm disorders, postoperative myocardial infarction, sternal dehiscence, this should be due to the relatively small number of studied cases. In spite of these, the significantly lower number of necessary blood units for the off-pump patients, the less mechanical ventilation time, make the cost of an off-pump intervention to be much lower then of an on-pump intervention [2,5,6,7]. Certainly, a significant importance in cost reducing also have the disposable materials (oxygenators, canullas), more expensive than the cardiac stabilizer.

Even if a lot of reports demonstrated a very favourable short-term grafts permeability rate for off-pump operated patients [5,6,8,9], recent studies on permeability at distance performed on large groups of 'off-pump' operated patients, show a higher rate of re-interventions for graft obstruction and a higher frequency of re-hospitalization for pectoral angina [2].

In 2005, the review of several clinical trials, accomplished by American Heart Association Council on Cardiovascular Surgery and Anesthesia in Collaboration With the Interdisciplinary Working Group on Quality of Care and Outcomes Research, outlined that patients may achieve an excellent outcome with either type of procedure, and individuals' outcomes likely depend more on factors other than whether they underwent standard on-pump or off-pump coronary bypass [10].

Other studies evaluated the benefit of off-pump interventions by assessing the pre-operative risk profile [11], the risk of stroke in connection with the use of extracorporeal circulation [12], or the advantages of off-pump myocardial revascularization in patients with acute coronary syndrome [13].

Our survey demonstrated that the off-pump myocardial revascularization is a safe method with a low rate of early complications and early mortality, and has decreased the use of limited and costly resources.

REFERENCES

[1]. Ascione, R., Lloyd, C.T., Underwood, M.J., Gomes, W.J., Angelini, G.D. (1999). On-pump versus off pump coronary revascularization: evaluation of renal function. Ann Thorac Surg, 68, 493-498. | | [2]. Arom, K.V., Flavin, T.V., Emery, R.W., Kshettry, V.R., Janey, P.A., Petersen, R.J. (2000). Safety and efficacy of off-pump coronary artery bypass grafting. Ann Thorac Surg, 69, 704-710. | | [3]. Bouchard, D., Cartier, R. (1998). Off-pump revascularization of multivessel coronary artery disease has decreased myocardial infarction rate. Eur J Cardiothorac Surg, 14(suppl 1), S20-24. | | [4]. Lancey, R.A., Soller, B.R., Salm, T.J.V. (2000). Off-pump versus on-pump coronary artery bypass surgery: a case-matched comparison of clinical outcomes and costs. Heart Surg Forum, 3(4), 277-281. | 5 | [5]. Boyd, W.D., Desai, N.D., Del Rizzo, D.F., Novick, R.J., Mckenzie, F.N., Menkis, A.H. (1999). Off-pump surgery decreased postoperative complications and resource utilisation in the elderly. Ann Thorac Surg, 68, 1490-1493. | | [6]. Calafiore, A.M., Di Giammarco, G., Teodori, G., Mazzei, V., Vitolla, G. (1998). Recent advances in multivessel coronary grafting without cardiopulmonary bypass. Heart Surg Forum -33589; 1, 20-25. | 5 | [7]. Engleman, R.M., Rousou, J.A., Flack, J.E., Deaton, D.W., Humphrey, C.B., Ellison, C.H. (1994). Fast –track recovery of the coronary bypasses patient. Ann Thorac Surg, 58, 1742-1746. | | [8]. Cartier, R. Systematic off-pump coronary artery revascularization: experience of 275 cases. (1999). Ann Thorac Surg, 68, 1494-1497. | | [9]. Puskas, J.D., Wright, C.E., Ronson, R.S., Brown, W.M., Gott, J.P., Guyton, R.A. (1998). Off-pump multivessel coronary bypass via sternotomy is safe and effective. Ann Thorac Surg, 66, 1068-1072. | | [10]. Sellke, F.W., Dimaio, J.M., Caplan, L.R., Ferguson, T.B., Gardner, T.J., Hiratzka, L.F., Isselbacher, E.M., Lytle, B.W., Mack, M.J., Murkin, J.M., Robbins, R.C. (2005). Comparing On-Pump and Off-Pump Coronary Artery Bypass Grafting. Circulation, 111, 2858-2864. | | [11]. Ferreira-Gonzalez, I.J., Ribera, A., Cascant, P., Permanyer-Miralda, G. (2006). Outcomes in off-pump vs. on-pump coronary artery bypass grafting stratified by pre-operative risk profile: an assessment using propensity score. European Heart Journal, 27, 2473 –2480. | | [12]. Reber, D., Fritz, M., Germing, A., Marks, P., Laczkovics, A. (2008). Early outcome after off-pump coronary artery bypass grafting: effect on mortality and stroke. Rev Bras Cir Cardiovasc, 23 (1). | | [13]. Kaya, K., Cavolli, R., Telli, A., Soyal, M.F.T., Aslan, A., Gokaslan, G., Mursel, S., Tasoz, R. (2010). Off-pump versus on-pump coronary artery bypass grafting in acute coronary syndrome: a clinical analysis. Journal of Cardiothoracic Surgery, 5, 31. |