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Off-pump coronary artery bypass grafting versus on-pump coronary artery bypass grafting: which is better in patients with chronic obstructive pulmonary disease?

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Abstract: To evaluate the clinic outcome of off-pump coronary bypass grafting (OPCABG) of patients with coronary heart disease and chronic obstructive pulmonary disease, we collected and analyzed 1998–2002 data on 28 patients with these two diseases who had received off-pump coronary bypass operation in our hospital, and compared with data on those who also had the same two diseases but received on-pump coronary artery bypass at same time. There were no operation-related death; one died of respiratory failure 14 days after operation while staying in hospital; there were more respiratory complications in the conventional coronary artery bypass grafting group (CCABG) than in the OPCABG group; and the PaO_2/FiO_2 in the CCABG group was higher than that in the OPCABG group during operation because of CPB, but lower than that in the OPCABG group 6–12 hours after operation. OPCABG seemed more suitable than CCABG for coronary artery disease patients with chronic obstructive pulmonary disease due to less damage to their oxygen-exchange capability and the fewer respiratory complications.

Key words: Chronic obstructive pulmonary disease, Coronary artery heart disease, Off-pump bypass, On-pump bypass, Respiratory function
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INTRODUCTION

Conventional coronary artery bypass grafting (CCABG) with cardiopulmonary bypass (CPB) has been accepted as an effective and safe treatment for multi-vessel coronary heat disease. CPB may still contribute to the operation field because of the relatively easier technical requirement; but it also causes a serious systematic inflammatory reaction which will lead to dysfunction of important organs and higher cost for the patients. Off-pump coronary artery bypass grafting (OPCABG) has recently emerged as an alternative method allowing coronary revascularization without use of CPB. Many studies suggested that OPCABG has more advantage in reducing postoperative cardiac complication and morbidity compared with on-pump or conventional coronary artery bypass grafting. As the number of elderly patients increases, many of them suffer from coronary artery disease as well as chronic obstructive pulmonary disease (COPD). Our study was aimed to get answers to the question: off-pump coronary artery bypass grafting versus on-pump coronary artery bypass grafting: which is

better for patients with chronic obstructive pulmonary disease?

METHOD AND PATIENTS

General clinical material

All of the 47 patients had a history of myocardial infarction or angina pectious, and had at least 3 vessel lesions which were confirmed by cardiac catheterization. According to the criteria of diagnoses and classification of COPD, which were determined by a respiratory specific subgroup of the Chinese Medical Association (CSRDCMA, 2002), they were classified to stage I: 6 cases; stage IIA: 19 cases; stage IIB: 13 cases; stage III: 9 cases, depending on the results of pulmonary function tests, blood gas test, auscultation finding and roentgenograms. Male/female ratio was 18/29, the mean age was 61.9 years. They were randomly divided into two groups that were candidates for CCABG or OPCABG from January 1998 till September 2002. Any high risk factor or combined problems such as valve disease, great artery disease; and cases of ejection fraction <30%, emergency or urgent operations, were excluded. Some of the patients suffered from other diseases besides COPD: 5 patients had dysfunction of liver and kidney, 7 patients had hypertension and 10 cases had diabetes (the clinical data are given in detail in Table 1).

All operations were performed by the same surgical team through a sternotomy incision and anastomosise of left internal mammary artery with the left anterior descending artery (LAD). The great saphenous vein was used mostly as a conduit, but the radial arteries, whose long-term potency is superior to that of saphenous vein grafts, was also harvested for possible use as a conduit in some cases; CCABG used both antegrade and retrograde blood cardioplegia for myocardial protection during the period of cardiac arrest. OPCABG required deep pericardial traction sutures in some patients; the right pleural space was opened in some patients to facilitate exposure of the circumflex coronary artery. Coronary artery stabilization system was purchased from Medtronic Company. After surgical procedure, both groups of patients were admitted to the intensive care unit (ICU), where they received ventilator assistance in a controlled mandatory ventilation mode, and were extubated as soon as clinically advisable.

Table 1 Patients clinical characteristics

Data	OPCABG	CCABG
No. of patients	28	19
Age	62.4±2.7	61.3±1.9
Female/male	16/12	12/7
Smoking history	20	15
COPD I-II	23	15
COPD III	5	4
Diseased vessel	3.4±0.2	3.1±0.4
Left main stem disease	7	5
LVEF (%)	49.1±2.9	51.4±3.4
High hypertension	3	2
Dysfunction of kidney	5	2
Diabetes	6	4
Parsonnet score	7.1±1.2	8.3±1.4

Blood sample test

Blood samples were taken for blood gas analysis before operation without oxygen supply, during anesthesia with oxygen supply, before CPB and post-operation 2 hours, 6 hours, 12 hours and 24 hours to observe the change of PaO_2/FiO_2.

Statistic analysis

The data are expressed as a mean±standard deviation; unpaired Student t test and χ^2 was used to analyze variables between two groups, a P value of less than 0.05 was considered statistically significant (SPSS 9.0).

RESULTS

There were no differences with regard to age, gender, diseased vessels, smoking history, previous myocardial infarction, renal insufficiency, and Parsonnet score, which did not include pulmonary test between two groups. Among them 4 patients who were scheduled to finish revascularization without CPB, required conversion to CCABG due to instability of blood pressure and ventricular arrhythmia during operation. Postoperative outcomes are shown in Table 2. OPCABG patients underwent

fewer bypass grafts per patient compared with CCABG patients and more saphenous vein grafts were used in OPCABG patients. Furthermore, there were also obvious differences in regard to chest drainage, time to extubation, reintubation times, intensive care unit time, stay time in hospital and ARDS occurrence. Some of them, however had no statistical value. No difference was found for total in-hospital deaths as well as reexploration for bleeding, pleural effusion, bronchospasm, pneumothorax and postoperative ventricular arrhythmia, intraaortic balloon pump and low output syndrome.

PaO_2/FiO_2 is a very important marker for evaluating the function of gas exchange of the lung during and after operation. Patients with CCABG had higher PaO_2/FiO_2 than patients with OPCABG because of CPB during operation, and there was no difference between the two groups for the first 2 hours after operation, but during 6–12 hours after operations the CCABG group had obviously lower PaO_2/FiO_2 than the OPCABG group (Table 3).

Table 2 Postoperative outcomes

Variables	OPCABG (*n*=28)	CCABG (*n*=19)	*P* value
Chest drainage (ml)	450±190	680±210	<0.01
Time of extubation (h)	13±10	18.7±12	<0.05
Delayed extubation	6	11	<0.05
Asthma/bronchospasm	4	3	>0.05
Reexploration for bleeding	3	1	>0.05
Pneumothorax	2	1	>0.05
Pleural effusion	4	2	>0.05
Reintubation	2	2	>0.05
ICU time (h)	21.2±2.5	16.8±4.5	<0.05
ARDS	1	5	<0.05
Tracheotomy	1	2	>0.05
In-hospital Deaths	1	0	>0.05
Stay time in hospital (d)	15.4±4.5	21.8±3.4	<0.05
IBPA*	3	1	>0.05
LOS*	1	1	>0.05
Postoperative MI	1	0	>0.05
PVA*	2	7	<0.05
No. of grafts	3.3±0.5	3.5±0.4	>0.05

*PVA: postoperative ventricular arrhythmia; IBPA: intraaortic balloon pump; LOS: low output syndrome

DISSCUSION

Chronic obstructive pulmonary disease (COPD) is characterized by the progressive development of airflow limitation that is not fully reversible; and includes chronic obstructive bronchitis, with obstruction and restriction of small airways and emphysema and enlargement of air space or destruction of the lung parenchyma, loss of lung elasticity and closure of small airways (Barnes, 2000). Patients (14.3%) with coronary heart disease in our hospital also suffered from COPD.

It is well known that CPB not only leads to pathologic effects including volume retention coagulopathy, release of systemic inflammatory mediators, reperfusion injury of heart and neurocognitive changes, but also interferes with pulmonary functions in patients undergoing CABG (Kit *et al.*, 2000; Mitchell *et al.*, 2002). Before the coronaryartery bypass on the beating heart without CPB was reintroduced into cardiac surgical practice, a lot of measures, such as aprotinin, heparinized circuit, were taken to reduce these detrimental side effects of extracorporal circulation. These effects seemed more serious and dangerous for the patients with COPD, because cardiopulmonary bypass has adverse effects on the alveolar stability by activation of the complement cascade, adherence and sequestration of the neutrophil in the pulmonary microvascular bed, releasing of the oxygen-derived free radicals and changing of the composition of alveolar surfactant. Because of the wide vascular bed and endothelium, the lung becomes the main

Table 3 The changes of PaO_2/FiO_2 in two groups at different times (mmHg)

	In operation		Post-operation			
	Before anaesthesia	CPB*	2 h	6 h	12 h	24 h
OPCABG (*n*=28)	342±24	310±23 (SHSO)*	281±36	273±14	278±19	311±11
CCABG (*n*=19)	340±20	352±21	278±23	244±18	238±12	301±23
P value	>0.05	<0.05	>0.05	<0.05	<0.05	>0.05

*SHSO: Starting heart surface operation; CPB: Cardiopulmonary bypass

target of in flammatory factors. Some studies showed a waterfall-like release after CPB inflammatory mediators such as interleukin-2, interleukin-6, and interleukin-8, whose peak times are between postoperative 4–12 hours (Corbi *et al*., 2000; Bull *et al*., 2001; Mustafa *et al*., 2001). That correlates with the change of PaO_2/FiO_2 which we had observed and reported in our paper. Patients with OPCABG showed mild change in it. That means the same severity of COPD would affect OPCABG less than CCABG.

The Parsonnet score widely recommended in many European heart centers, was used to evaluate the preoperative condition in our hospital, but the OPCABG's high risk factor profiles were different from the CCABG's. Even though the Parsonnet scores of the two groups in our hospital were the same, the respiratory complication of the two groups had obvious differences. Our results also accorded with previous report on the hospital mortality and morbidity of COPD patients who underwent CABG l (Ferguson Jr *et al*., 2002; Corbi *et al*., 2000). Rational Parsonnet score evaluation needs further modification due to the changing of method of operation for CABG.

Nearly all COPD patients need following mechanical ventilation after operation. Positive end-expiratory pressure is still in controversy because COPD patients who have increased functional residual volume and PEEP will have enhanced lung volume. Thus some surgeons are worried that post-operative PEEP will increase internal mammary artery tension and cause spasms leading to post-operative myocardial infarction. Our experience showed that 4–8 cm H_2O PEEP reduced extravascular water in the lung and was suitable for patients with congestive heart failure before operation. Reintubation was often needed because of continuous hypoxemia. Pharmacological intervention played a very important role in improving the respiratory dysfunction. Inhaled long-acting β_2-agonists and corticosteroids are now the mainstay of therapy, the use of non invasive positive-pressure ventilation with a simple nasal mask, which eliminates the necessity for endotracheal intubation, reduces the need for mechanical ventilation in acute exacerbation of COPD in the hospital (Barnes, 2000; Samuels *et al*., 1998).

To conclude, with less adverse effects of CPB such as systemic inflammatory reactions, postoperative organ dysfunction and significant coagulatory disorders, OPCABG has less respiratory complication and is safer than CCABG for patients with COPD.

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