Coronary Artery Bypass Surgery

Beating Heart or Cardiopulmonary Bypass?

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Summary

In this study, we examined the early results for patients who underwent beating heart coronary bypass surgery and compared these results with those of conventional coronary bypass surgery.

A total of 1094 patients who underwent isolated coronary artery bypass surgery between January 2009 and December 2011 in our clinic were included in this study. Seventy-three patients in whom cardiopulmonary bypass was not used (group 1) were compared to 1021 patients in whom cardiopulmonary bypass was used (group 2).

The mean age was 60.7 ± 9.3 in group 1 and 58.9 ± 9.7 in group 2 ($P > 0.05$). There was no significant difference between the two groups in terms of gender, or the coexistence of diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), and hypertension ($P > 0.05$). There was no significant difference between group 1 and group 2 in terms of development of postoperative atrial fibrillation (AF), use of an intra-aortic balloon pump, need for re-operation for bleeding, or duration of hospital stay and intensive care unit stay ($P > 0.05$). The need for inotropic support and the amount of mediastinal drainage were less in group 1 than in group 2 ($P = 0.002$, $P < 0.001$). The incidences of postoperative cerebrovascular accident, development of chronic renal failure, and sternal wound infection did not significantly differ between the groups ($P > 0.05$). There was no mortality in group 1, whereas it was calculated as 1.8% in group 2 ($P = 0.63$).

Beating heart coronary artery bypass surgery decreases the need for inotropic support and transfusion. (Int Heart J 2014; 55: 29-32)

Key words: Mortality

Coronary artery bypass surgery is an effective and safe treatment modality in patients with coronary artery disease. It can be performed either on a beating heart or under cardiopulmonary bypass support in many centers. The anatomy of the coronary arteries and the preference and experience of the surgeon play significant roles in selection of the intended procedure. In addition, concerns about safe and adequate revascularization, hemodynamic instability, ventricular arrhythmia, or cardiac arrest are among the important factors that hinder beating heart coronary artery bypass surgery. In recent years, the prevalence of beating heart surgery has increased secondary to gained surgical experience and techniques to establish an immobile surgical field. Some studies report that beating heart surgery has better operative results, whereas some others have reported there is no difference between beating heart and conventional surgery.[1,2)] In this study, we examined the early results for patients who underwent beating heart coronary bypass surgery and compared these results with those of conventional coronary bypass surgery.

Methods

The subjects were 1094 patients who underwent coronary artery bypass surgery between January 2009 and December 2011 at our clinic. No specific patient selection criteria were available. All of the patients undergoing isolated coronary artery bypass grafting in that period were included. Patients needing carotid or valvular surgery were also excluded from study. Seventy-three patients in whom cardiopulmonary bypass was not used (group 1) were compared to 1021 patients in whom cardiopulmonary bypass was used (group 2). Routine transthoracic echocardiography was carried out in all patients before surgery and the ejection fraction was calculated by Simpson's method. Fentanyl citrate (fentanyl citrate, Abbott) and midasolam (Dormicum, Roche) were used for induction of anesthesia, and sevofluorane (Sevorane, Abbott) and vercuronium bromide (Norcuron, Organon) were used for maintenance of anesthesia. Selection of the method of coronary bypass surgery either on-pump or off-pump was done according to the anatomy of the coronary lesions and surgeon preference. Heparin (2 mg/kg, Nevparin, Mustafa Nevzat) was used in

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beating heart operations and 4 mg/kg heparin was used under cardiopulmonary bypass operations. A coronary stabilizer and heart positioner were used in beating heart operations. In operations under cardiopulmonary bypass, mild systemic hypothermia was applied and cardiac arrest was maintained by warm blood cardioplegia given antegradely through the aortic root. Cardioplegia given through the aortic root was repeated every 20 minutes throughout cardiopulmonary bypass. Antegrade cardioplegia was performed through the proximal end of the saphenous vein grafts after each distal anastomosis of saphenous vein grafts. Proximal anastomosis was performed using side clamps. Complete revascularization was performed in all patients (group 1 and group 2). Neutralization of the heparin was maintained by protamine hydrochlorure (Protamine ICN, Onko) in ratios of 1:1. The left internal mammarian artery was used in 66 (90.4%) patients in group 1 and in 932 (91.2%) patients in group 2. The right internal mammarian and radial arteries were not used as a conduit. Demographic properties of the patients, operational data, and postoperative complications were registered. Patients that needed permanent hemodialysis postoperatively were considered to have chronic renal failure. Mortality was defined as post-operative mortality within 30 days after the operation.

Statistical analysis: The SPSS 18.0 program was used in anolyzing the data statistically. Qualitative data are summarized as numbers and percentages and quantitative data are summarized as the mean and standard deviation (if necessary as mean; minimum; and maximum). The chi-square test was used to compare the quantitative values between the two groups. In comparing quantitative data between binary groups, the *t* test was used in hypothetical groups and the Mann-Whitney *U* test was used in nonhypothetical groups. When comparing numerical measurements of more than two groups, one-way variance analysis was used for hypothetical ones, and the Kruskal-Wallis test was used for nonhypothetical ones. Logistic regression analysis was used to determine mortality risk factors. The statistical significance level was 0.05.

Results

We performed beating heart coronary bypass grafting in 73 cases (6.6%) out of a total number of 1094 cases that underwent isolated coronary bypass surgery. The mean age was 60.7 ± 9.3 in group 1 and 58.9 ± 9.7 in group 2 ($P = 0.140$). There was no significant difference between the two groups in terms of gender, coexistence of diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), and hypertension ($P = 0.592$, $P = 0.605$, $P = 0.209$, $P = 0.540$). Preoperative demographic data are presented in Table I. The operation time was 85.20 ± 22.77 minutes in group 1 and 186.26 ± 28.97 minutes in group 2 ($P < 0.001$). No significant difference was found between group 1 and group 2 in terms of development of postoperative atrial fibrillation (AF), use of intra-aortic balloon pump, need for re-operation for bleeding, or duration of hospital stay and intensive care unit stay ($P = 0.392$, $P = 0.315$, $P = 0.720$, $P = 0.631$, $P = 0.409$). The need for inotropic support and the amount of mediastinal drainage were less in group 1 than in group 2 ($P = 0.002$, $P < 0.001$). Likewise, the incidence of postoperative cerebrovascular accident, development of chronic renal failure, and sternal wound infection did not significantly differ between the groups ($P = 0.273$, $P = 0.273$, $P = 0.677$). There was no mortality in group 1, whereas it was calculated to be 1.8% in group 2 ($P = 0.63$). The mean number of grafts per case was 1.81 ± 0.72 (1-3) in group 1 and 2.66 ± 0.80 (1-5) in group 2 ($P < 0.001$). Intraoperative and postoperative characteristics of the cases are shown in Table II. As a result of multivariant analyses performed for mortality, there was no significant difference between off-pump and on-pump groups ($P > 0.05$). The most important parameters that affected mortality were cardiopulmonary bypass time and use of an intra-aortic balloon pump (Table III). There was no significant difference between group 1 (5 patients) and group 2 (87 patients) in terms of the frequency of left main coronary artery disease ($P = 0.619$). The differences in the severity of coronary artery disease in each group are presented in Table IV. The ra-

Table I. Preoperative Demographic Characteristics of the Cases

	Group 1 ($n = 73$)	Group 2 ($n = 1021$)	*P*
Age	60.7 ± 9.3	58.9 ± 9.7	> 0.05
Male gender	50	731	> 0.05
Female gender	23	290	> 0.05
DM	21	329	> 0.05
HT	28	437	> 0.05
COPD	7	61	> 0.05
EF (%)	44.5 ± 19	46.8 ± 18.7	> 0.05
Preoperative CRI	0	0	> 0.05

DM indicates diabetes mellitus; HT, hypertension, COPD; chronic obstructive pulmonary disease, EF, ejection fraction; and CRI, chronic renal insufficiency.

Table II. Intraoperative and Postoperative Characteristics of Cases

	Group 1 ($n = 73$)	Group 2 ($n = 1021$)	*P*
Drainage (mL)	549.3 ± 315.2	629 ± 437.3	> 0.05
Reoperation	1	32	> 0.05
Need for inotropic support	13	360	< 0.05
Blood transfusion (mL)	276.7 ± 229.4	442.4 ± 397	< 0.05
CVA	0	2	> 0.05
IABP	2	15	> 0.05
Sternal wound infection	1	13	> 0.05
CRI	0	2	> 0.05
Mean number of grafts per case	1.81 ± 0.72	2.66 ± 0.80	< 0,05
Exitus	0	19	> 0.05

CVA indicates cerebrovascular accident, IABP: intra-aortic balloon pump, and CRI: chronic renal insufficiency.

Table III. Multivariant Analyses for Mortality

	P	OR	95% confidence interval for OR
CPB time (minutes)	< 0.001	1.024	1.012-1.037
IABP	0.002	10.512	2.415-45.764
Drainage (mL)	0.050	1.067	1.000-1.135
Blood transfusion (mL)	0.029	1.058	1.000-1.110

CPB indicates cardiopulmonary bypass, OR: Odds ratio, and IABP, intraaortic balloon pump.

Table IV. Differences in Severity of Coronary Artery Disease

	Group 1 (n = 73)	Group 2 (n = 1021)	P
1-vessel disease	27 (%37)	51 (%5)	< 0.001
2-vessel disease	33 (%45)	383 (%37.5)	0.191
3-vessel disease	13 (%18)	587 (%57.5)	< 0.001

tio of single-vessel disease was higher in group 1, whereas the ratio of 3-vessel disease was higher in group 2 ($P < 0.001$).

Discussion

Coronary artery bypass grafting can be performed either with a cardiopulmonary bypass or on a beating heart without cardiopulmonary bypass. Some institutions prefer beating heart surgery as the first line regardless of whether it is multivessel disease or not.[3] Prior studies have demonstrated that beating heart operations had superior results compared with operations with cardiopulmonary bypass.[4,5] Some authors have argued that beating heart surgery yields better results in females.[6] Some relatively recent studies have indicated that both techniques are similar in terms of long-term results.[1,7] In our study, no mortality was detected in beating heart operations. No significant difference was found between the 2 groups in terms of mortality rate. We believe that better surgical results are being obtained in on-pump coronary bypass surgery with the advances in technology and myocardial protection techniques, as well as improving surgical experience.

Cardiopulmonary bypass may cause myocardial dysfunction.[8] Therefore, some surgeons prefer to perform beating heart coronary bypass surgery as the treatment of choice, particularly for patients with left ventricular dysfunction. Cantero, *et al* indicated that the need for intra-aortic balloon pump counter pulsation (IABP) was less necessary among patients operated with a beating heart.[9] Abud, *et al* reported that beating heart operations did not have any effect on the postoperative need for IABP.[10] In our study, we found no significant difference between the 2 groups in terms of the need for IABP, but the need for inotropic support was less in beating heart operations. Meherwal, *et al* compared patients undergoing on-pump surgery with patients undergoing off-pump surgery. They found no significant difference between the 2 groups in terms of postoperative need for inotropic support.[5] As in our study, Putnik and colleagues reported that patients undergoing off-pump surgery needed less inotropic support.[2]

In a study conducted by Godinho, *et al*, there was no significant difference between off-pump and on-pump surgery in terms of the incidence of postoperative renal complications and infection.[11] In our study, we did not observe any significant difference between the 2 groups in terms of development of postoperative renal insufficiency and sternal wound infection. Two studies reported the incidence of postoperative cerebrovascular accident was lower after beating heart coronary bypass grafting.[4,6] On the other hand, Abud, *et al* reported that there was no significant difference between these two techniques in terms of postoperative development of cerebrovascular accidents.[10] Likewise, we did not notice any significant difference between the 2 groups in terms of postoperative development of cerebrovascular accidents in our study.

Atrial fibrillation is a significant cause of mortality and morbidity after coronary artery bypass surgery.[12] Some studies have demonstrated that beating heart surgery caused atrial fibrillation less frequently.[13] Other studies did not confirm these data.[1] In our study, we did not find any significant difference between the 2 groups in terms of development of postoperative atrial fibrillation. We believe that beating heart surgery does not affect the incidence of postoperative atrial fibrillation.

In cardiac surgery, it was demonstrated that the mortality and morbidity rates increase as the amount of transfused blood products increases.[14] Many studies have declared that the amount of mediastinal drainage and transfused blood products is less in beating heart surgery.[4,13] Likewise, we found that the amount of blood products transfused was less in beating heart surgery. Regarding the adverse effects of use of blood products, we think that beating heart surgery would have better results.

Conclusion: Beating heart coronary artery bypass surgery decreases the need for inotropic support and transfusion.

Limitations of the study: Our study is a retrospective study conducted at a single center. The number of patients in group 1 was small, because patient selection was biased by the operating surgeon. This decision was based on coronary arterial anatomy, hemodynamic disturbances, arrhythmias and cardiac arrest. There are differences in severity of coronary disease and operation time between groups 1 and 2.

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