

# Off-Pump Coronary Artery Bypass Grafting for Elderly Patients

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**Background.** The use of off-pump coronary artery bypass grafting (CABG) has recently become widespread, and it has been proven to be less invasive and to facilitate early recovery. In this study, we investigated the efficacy of off-pump CABG for patients aged 75 years or more.

**Methods.** A retrospective chart review was carried out for patients who underwent isolated off-pump and on-pump CABG at Shin-Tokyo Hospital between January 1997 and December 2000. The patients' demographic, operative data, and postoperative results were collected.

**Results.** The off-pump group consisted of 60 men and 44 women with a mean age of 78.8 years, and the on-pump group consisted of 54 men and 20 women with a mean age of 77.6 years. Distal anastomoses were significantly fewer in the off-pump group (2.4 in off-pump group versus 3.7 in on-pump group), but total arterial bypass was more frequently achieved in off-pump group (82.7% versus 25.7%). Intubation time (8.4 versus 18.4

hours), intensive care unit stay (2.2 versus 3.5 days), and postoperative stay (13.8 versus 20.0 days) were significantly shorter in the off-pump group than in the on-pump group ( $p < 0.05$ ). The frequency of the occurrence of major complications was significantly lower in the off-pump group than the on-pump group, especially in regard to postoperative stroke and respiratory failure ( $p < 0.05$ ). Multivariate analysis showed that off-pump CABG significantly reduced patient recovery period and the incidence of postoperative complications. Early follow-up results, cardiac event-free and survival rates, did not significantly differ between the two groups.

**Conclusions.** Off-pump CABG is safe for the elderly patient. Off-pump CABG successfully facilitates early recovery and reduces the incidence of postoperative complications among elderly patients.

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The elderly population has been increasing in Western countries as well as in Japan. Coronary artery bypass grafting (CABG) for the elderly patient carries significant operative risks, and we previously reported the results of CABG for elderly patients [1]. Recently, the use of off-pump CABG has become widespread and it has proven to be less invasive [2]. To minimize operative mortality and morbidity, off-pump CABG has been utilized for the past 3 years in our institution. In this study, we retrospectively analyzed the inhospital and early follow-up data of the patients who underwent off-pump CABG at Shin-Tokyo Hospital, focusing on patients aged 75 years or more, and compared the findings with the results of patients in the same age group who underwent conventional on-pump CABG.

## Patients and Methods

Between January 1, 1997, and December 31, 2000, a total of 1,095 patients underwent isolated CABG at Shin-Tokyo Hospital. Among them, 178 patients (16.3%) were

aged 75 or older. The patients were divided into two groups according to the use of cardiopulmonary bypass (CPB) during the CABG. The off-pump group consisted of 104 patients (60 men and 44 women, mean age of 78.8 years) and the on-pump group consisted of 74 patients (54 men and 20 women, mean age of 77.6 years). Their medical records were retrospectively reviewed, and the following information was collected; patient age, sex, results of preoperative angiography, cardiac profiles, preoperative risk factors, graft materials, surgical data, postoperative complications, and mortalities. Definitions of the preoperative risk factors and postoperative complications were made according to The Society of Thoracic Surgeons criteria. Major complications were defined as life-threatening complications such as low output syndrome, postoperative myocardial infarction, postoperative stroke, mediastinitis, reexploration for bleeding, pneumonia, respiratory failure requiring reintubation or ventilator support for more than 5 days, and hemodialysis. Patients who had undergone valvular surgery, left ventricular surgery, or surgery related to other vascular or major general surgery procedures were excluded from the study. Remote cardiac events included angina recurrence, percutaneous transluminal coronary angioplasty (PTCA), congestive heart failure requiring admission, arrhythmia requiring admission, and sudden death.

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We described the methods of conventional on-pump and off-pump CABG in our previous report [2]. Briefly, CPB for on-pump CABG was run at normothermia (36°C) and cardioplegia was given antegradely or retrogradely, or both, to achieve cardiac arrest. It was our hospital policy not to use general hypothermia or topical cooling for isolated CABG. Off-pump CABG was performed in two different ways: the first was minimally invasive direct coronary artery bypass (MIDCAB), which was approached through a left fourth or fifth intercostal small thoracotomy and allowed us to bypass the left anterior descending artery (LAD) with the left internal mammary artery (LIMA), with the heart beating; the other was off-pump CABG through midsternotomy (OPCAB), which was approached through midline sternotomy and allowed us to perform single or multivessel revascularization. In selected cases, an intracoronary shunt-tube was used to maintain distal perfusion during anastomosis. As mentioned in our previous report, we used different types of coronary stabilizer to perform OPCAB [2]. Before February 28, 1999, a compression device (Ring system; US Surgical, Norwalk, CT) was used for local coronary stabilization. The utility of this first generation of coronary stabilizing system was limited to the anterior surface of the heart and the procedure to the left circumflex artery (LCX) area was extremely restricted. After March 1, 1999, a second generation of stabilizer (suction device, Octopus-2; Medtronic, Minneapolis, MN) was used in our institute. The suction device, combined with the use of the retropericardial sutures, allowed us to perform bypass grafting on any surface of the heart while the heart was beating [3].

Postoperative angiography was performed in patients with normal renal function with the patient's consent. In the off-pump group, angiography was systematically performed to verify the quality of anastomoses. In the on-pump group, angiography was performed if the quality of native coronary arteries was poor or if it was requested by the referring cardiologists.

Statistical analyses were performed using Student's *t* tests for continuous variables or  $\chi^2$  tests (Fisher's exact tests if  $n < 5$ ) for categorical variables. Results were expressed as the mean  $\pm$  SD. Postoperative patient survival and event-free rates were calculated using the Kaplan-Meier method and compared using the Mantel-Cox log rank tests. A *p* value less than 0.05 was considered significant. Relative risk (RR) was calculated by logistic regression analysis and expressed with 95% confidence interval (CI). Since mean intubation period, intensive care unit (ICU) stay, and postoperative stay for young (age  $\leq$  75) patients in our previous study [1] were 12 hours, 3 days, and 18 days, respectively, a prolonged intubation period, ICU stay, and postoperative stay were defined as longer than 12 hours, 2 days, and 18 days, respectively. Significant variables by univariate comparisons were further analyzed by multivariate logistic regression analysis. All statistical analyses were performed using Statview version 5.0 (SAS Institute, Cary, NC).

## Results

The preoperative data for each group are shown in Table 1. Patients with three-vessel disease were more often treated by on-pump CABG, but the frequencies of emergent or redo surgery, coronary risk factors, and coexisting medical problems were equally distributed.

Operative data are shown in Table 2. MIDCAB was performed in 24 cases in which the mean distal anastomoses were  $1.0 \pm 0.2$ , and OPCAB was performed in 80 cases in which the mean distal anastomoses were  $2.4 \pm 1.1$ . With the advancement of the coronary stabilizing system, the number of distal anastomoses was increased from  $2.2 \pm 0.4$  using a compression device, to  $2.9 \pm 0.9$  using a suction device ( $p < 0.0001$ ); however, these figures were significantly lower than for on-pump CABG ( $3.7 \pm 1.0$ ,  $p < 0.0001$ ). Venous bypass was used in a small number of cases in the off-pump group while three quarters of on-pump patients had at least one saphenous vein grafted. Total arterial bypass was more frequently performed in the off-pump group (86 patients, 82.7%) than in the on-pump group (19 patients, 25.7%),  $p$  less than 0.0001. The requirement of blood products in the off-pump group was significantly lower than in the on-pump group.

Postoperative courses are shown in Table 3. Intubation period (8.4 hours in the off-pump group versus 18.4 hours in the on-pump group), ICU stay (2.2 versus 3.5 days), and postoperative hospital stay (13.8 versus 20.0 days) were all significantly shorter in the off-pump group than in the on-pump CABG group. There were 2 in-hospital deaths in the off-pump group. One was an 84-year-old man who underwent emergent off-pump CABG for the salvage of acute myocardial infarction; however, he was inotropics-dependent postoperatively, renal failure subsequently developed, and he died 7 days after surgery. The other was a 76-year-old man who underwent elective two vessel revascularization. Postoperatively, he had a myocardial infarction due to native coronary artery spasm despite patent anastomoses. Intraaortic balloon pumping was effective to improve his hemodynamics; however, pneumonia developed and he died on postoperative day 41. The frequency of hospital death was not significantly different between the two groups. Postoperative major complications were less frequently observed in the off-pump group (10.6% in the off-pump group versus 28.4% in the on-pump group),  $p$  less than 0.01. Significant differences were observed in terms of the occurrence of postoperative cerebral vascular accident (1.0% versus 8.1%,  $p < 0.05$ ) and respiratory failure (1.9% versus 12.2%,  $p < 0.05$ ).

Preoperative risk factors shown in Table 1, excluding factors of acute myocardial infarction, which was closely related to emergent surgery, were entered into logistic regression analysis in order to identify the predictors influencing postoperative outcomes. Requirement of blood transfusion, prolonged intubation ( $> 12$  hours), prolonged ICU stay ( $> 2$  days), prolonged postoperative stay ( $> 18$  days), occurrence of major complications, and occurrence of postoperative stroke were analyzed using

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