

# Historical Background and Current Problems of OPCAB in Japan and Some Candid Advice

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## Historical Background of OPCAB in Japan

Coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI) are established remedies for myocardial revascularization of ischemic heart disease. PCI was initially adopted for use in single-coronary vessel disease only. CABG was used for most other coronary diseases. With the progression of PCI techniques and devices in the 1980s and 1990s (bare metal stents were approved in Japan in 1993), the indication of CABG narrowed and was eventually used in the treatment of advanced three-vessel disease and left main trunk disease only. The first CABG was performed in Japan in 1970 by Dr. Sezai without using cardio-pulmonary bypass (CPB).<sup>1)</sup> However, compared to western countries, the use of CABG in Japan was very low in the 1970s, and was associated with more complications and higher mortality. Therefore, Japanese cardiologists treated coronary disease themselves rather than referring patients to surgeons. Through the efforts of cardiologists, the level of PCI grew and became the leading treatment of coronary artery disease in Japan. At the same time many young cardiac surgeons went to learn coronary artery surgery abroad in the US, UK, Australia, and New Zealand, where CABG had excellent results. Subsequently CABG techniques in Japan were refined in the 1980s, results improved, and the procedure transformed into sophisticated surgery with widespread use of arterial grafts. Although the level of CABG in Japan reached that of other advanced countries, the ratio of PCI to CABG cases in Japan continued to grow.

As PCI numbers increased, CABG cases decreased, with the patients tending to be much older, with comorbidities, and tendency to develop postoperative com-

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plications. In particular there remained one rare but unavoidable problem: perioperative cerebral infarction. Surgeons thought it was caused by aortic cannulation, aortic clamping, micro-embolism by CPB, or hypoperfusion of the brain due to non-pulsatile flow of CPB. As a result surgeons began to search for new CABG techniques that could avoid the complications of CPB. Some surgeons learned from PCI procedures that the myocardium could tolerate transient ischemia. In 1998 Dr. Yokoyama, a Japanese cardiac surgeon who emigrated to the US, performed off-pump CABG (OPCAB) at Okayama University Hospital for Professor Sano and a group of other surgeons. This led to Japanese surgeons performing OPCAB in selected patients.

Since 2000 the number of OPCAB procedures performed in Japan has increased with the emergence of new devices such as the suction stabilizer,<sup>2,3)</sup> intra-coronary shunts, CO<sub>2</sub> blower, and the apical suction device (heart positioner).<sup>4-6)</sup> The proportion of CABG performed off-pump increased from 22% in 2000 to 62% in 2004—a threefold increase in four years! In 2005 the ratio decreased slightly to 61%.<sup>7,8)</sup> Despite this decline, Japan's current OPCAB ratio is the highest in the world and has a very low operative mortality: 0.97% in 2004. However, to date there have been no articles discussing the popularization of OPCAB in Japan.

I believe the popularity of OPCAB in Japan is due to the following: (i) Rapid PCI adoption over the past ten years and belief that less invasive OPCAB was compatible with PCI. (ii) Sharp increase in the number of older, high-risk patients receiving OPCAB to avoid complications. (iii) The belief that surgical departments routinely doing OPCAB are better at CABG. Some cardiologists and patients and their families believed OPCAB indicated a surgeon's skill level. This belief was created by both the mass media and a select group of cardiac surgeons. (iv) Aggressive nationwide promotion, including live operations and conferences, led by cardiac surgeons who demonstrated the superiority of OPCAB to CPB-CABG. I feel this reason is especially important. A few Japanese surgeons, impressed with OPCAB and believing it had a

bright future, got together and established “The Japanese Association for Off-Pump CABG” in May 1999. The first association conference was held in Tokyo in July 1999, and a session has been held in summer ever since. Foreign OPCAB surgeons are invited to lecture about techniques and theory, and approximately 350–400 surgeons across Japan participate. Also, a live demonstration has been held at every meeting since the 3rd session. These meetings are unique because there is no commercial base and participating surgeons are volunteers. There is no doubt that this association contributed to the spread of OPCAB techniques and provided both junior and senior surgeons the opportunity to learn about OPCAB.

## Current Problems in OPCAB

Next I would like to highlight some current problems in OPCAB and comment on them regarding comparison with CPB-CABG.

### 1. Techniques are still highly demanding

As a result of the development of new devices, especially the suction stabilizer, which provides a stable field, and the heart positioner which enables retraction of the heart, considerable advances have been made in distal anastomosis techniques. Before the advent of the suction stabilizer, surgeons used a parachute technique with double strings; making the anastomosis much more complicated. Today, however, the distal anastomosis can be done in the same fashion as CPB-CABG using a running suture technique. The heart positioner prevents hemodynamic disturbance by lessening distortion of the right ventricle and mitral annulus. This made it possible to graft to the circumflex and distal RCA region more easily, overcoming a problem with OPCAB. Even with these devices it is still difficult to gain ample working space for performing OPCAB on the back of the heart when it is large.

### 2. Difficulty in achieving complete revascularization

CPB-CABG has superiority to PCI in achieving more complete myocardial revascularization. OPCAB, however, has some limitations in achieving complete revascularization. With current advanced devices most surgeons are able to bypass arteries >1.25 mm in diameter. Despite this, reports showed the number of grafts performed in OPCAB was less than that of CPB-CABG.<sup>7,8)</sup> There are also reports that OPCAB has a higher incidence of recurrence of angina pectoris.<sup>9,10)</sup> OPCAB surgeons tend to select a more proximal anastomotic site on the target

coronary artery than CPB-CABG surgeons. It is well known that some grafts occlude because coronary distal disease progresses to the anastomotic site. Also, if OPCAB is done with aorta no-touch technique using in-situ arterial grafts and Y/T arterial grafts there is the possibility of graft occlusion or string phenomenon due to flow competition.<sup>11,12)</sup> These technical difficulties can lead to lower anastomosis quality and the possibility of incomplete revascularization. Because of this possibility, the quality of anastomoses should be checked intraoperatively using fluorescence imaging<sup>13)</sup> and/or transit time flow measurement.<sup>14)</sup>

### 3. High mortality associated with conversion to on-pump CABG

Conversion to on-pump CABG is one of the most significant problems in OPCAB. Some reports<sup>15,16)</sup> indicate that conversion to on-pump CABG results in high mortality and morbidity. Conversion may be caused by improper indication for OPCAB, immature OPCAB technique, or poor cooperation between the anesthesia staff and surgeon. Unless there is an absolute contraindication to CPB, in elective OPCAB cases, shifting to CPB-CABG should be considered when blood pressure drops markedly with an elevation of the pulmonary arterial pressure after induction of anesthesia. In such a situation, observing the heart by trans-esophageal echo is mandatory as there may be progressive mitral regurgitation; in which case the best surgical choice would be a combination of CPB-CABG and mitral valve surgery. If the heart is retracted to access the circumflex branch, and blood pressure can not be maintained over 80 mmHg in spite of the use of body positioning, an increase in preload, or administration of vasopressor or catecholamine, then it is essential to quickly reposition the heart in the pericardial cavity. If repositioning does not improve hemodynamic stability then it is essential to convert to on-pump CABG. In such a case it is likely the anastomosis to the LAD or RCA was insufficient beforehand. This will be evidenced by signs of myocardial ischemia on the ECG monitor and reduced movement in the bypassed region.

### 4. High level of anesthesia technique required

The role of anesthesia in OPCAB is much more important than in CPB-CABG. Especially when performing OPCAB to the circumflex branch and distal branch of the RCA, the patient's life depends on the anesthesiologist's ability and surgeon's skill. Communication and mutual reliance are crucial for success. Anesthesiologists

are aware of hemodynamic deterioration or arrhythmia much faster than surgeons, and can recommend an earlier conversion of OPCAB to CPB-CABG. If the level of anesthetic skill is not sufficient for performing OPCAB, surgeons should choose CPB-CABG.

### 5. Difficulty in educating young surgeons

Even experienced surgeons may face a long learning curve to master OPCAB. Consequently teaching OPCAB is difficult; although there are reports that a trainee can do multiple OPCAB surgeries under the supervision of a trainer at their level.<sup>17)</sup> When operating on the circumflex branches and RCA distal branches the visible area is limited, and the trainer can not see the operating field well enough for proper instruction when standing in the first assistant position. While certain technical skills are common to CPB-CABG, skills like applying a stabilizer, putting in epicardial stitches, inserting a coronary shunt, exposing the posterior aspect of the heart using a heart positioner, and using an aortic no clamping device are specific to OPCAB. These skills require some level of practical tuition for any surgeons to master. As a first step I recommend an instructor let trainees stand at the first assistant position and do OPCAB to the LAD and diagonal branch.

### Some Candid Advice

Although OPCAB still has various problems, many clinical studies demonstrate superior outcomes to CPB-CABG. OPCAB benefits include shorter respirator time, shorter ICU and hospital stay, less incidence of stroke in the elderly and/or patients with atherosclerotic ascending aorta, less blood transfusion, and lower medical cost.<sup>18–22)</sup> Finally I would like to make one more remark on OPCAB. There was only one choice of CABG before the advent of CPB: off-pump CABG. Before the new devices became available, there was only one choice of CABG: on-pump CABG. Cardiac surgeons now are able to choose OPCAB or CPB-CABG according to the patient's condition, surgeon's ability, and/or anesthesiologist's ability. At present, OPCAB has two different roles. One is applicable for complicated and/or elderly patients who need CABG but are considered high risk for CPB. In this role the completeness of revascularization and selection of grafts is not very important. Graft selection should be based on what is safest for the patient. The other role is to eliminate the adverse effects of CPB. In this setting complete revascularization

with high graft and anastomosis quality is paramount, as in CPB-CABG. Whatever the reason for choosing OPCAB, it should be performed using advanced surgical devices, trans-esophageal and epi-aortic echocardiography, intraoperative graft assessment devices, and a high level of anesthesia support. If the hemodynamic condition becomes unstable and its deterioration is anticipated by the surgeon and anesthesiologist, then conversion to on-pump CABG to evaluate the suspect anastomosis and/or complete the rest of the bypass grafts is mandatory. Surgeons must always keep the possibility of CPB-CABG in their minds even though it carries latent risks.

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