Editorial

CABG for Patients on Hemodialysis: Comments at Present

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There are no objections to the effectiveness of coronary intervention on improving myocardial ischemia secondary to coronary atherosclerosis. At present we have two valuable procedures for coronary intervention, coronary artery bypass grafting (CABG) and percutaneous catheter intervention (PCI). Both modalities are substantially valid for treating the coronary lesions of patients chronically maintained on hemodialysis (HD), as well as patients without renal dysfunction.

Increasing Number of Patients

The number of patients on HD has increased throughout the world, including Japan. Every year in Japan, 30,000 people begin regular HD treatment, and 20,000 patients on HD die. Therefore the total number of HD patients annually increases by 10,000.

The number of CABG patients on HD has increased in Japan, though the total number has not. In Japan there was a big change in CABG in the early 2000s because of the prevalence of off-pump CABG, which comprises over 60% of CABG cases during the past several years. What are the results of off-pump CABG for patients on HD in Japan? The in-hospital mortality rate of off-pump primary elective CABG for dialysis patients in 2006 was 5.7% (38/672), and that of primary elective on-pump patients was 4.0% (13/321); in 2007 these figures were 3.7% (24/655) and 5.6% (13/231).[1,2] Recent reports from Western countries have shown that off-pump CABG has brought a drastic improvement in early mortality and morbidity, compared to on-pump CABG.[3–5] Which is the best procedure for patients on HD? Before entering this discussion, we will introduce general problems on CABG for this group.

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Calcification and Countermeasure

The first problem of patients on HD is calcification of the coronary artery. There are three ways to resolve the calcification of the bypass target. (1) Put the bypass graft on its calcification free branches rather than the main artery. (2) Put it on the more distal artery without calcification. (3) Choose a less-calcified site to put it on. During the anastomosis of the third setting, it is important to put a needle in the soft part even if it is slightly far from the ideal point, and also to get more epicardial tissue than usual to attain certain hemostasis.

Calcification involves the ascending aorta so often that arterial cannulation is interrupted in on-pump CABG, and proximal anastomosis becomes very difficult. In this setting, the arterial cannulation site can be shifted to the subclavian artery if it is free from calcification. And if the subclavian artery is on the same side as the internal thoracic artery (ITA) chosen as a bypass graft, the artificial graft should be placed between the subclavian artery and a cannula. If one hole is made in the less-calcified site of the ascending aorta, at least two or three grafts can be placed by using a heartstring and the technique of combining side-to-side anastomosis of the saphenous vein graft (SVG) to the ascending aorta, and the end-to-end anastomosis of the SVG to another SVG. In any case, preoperative CT scanning and intraoperative periaortic echo examination are very important to detect calcification of the ascending aorta.

Selection of Graft

The expected life span of patients on HD is shorter than in normal people. In Japan, the 10-year survival rate of patients in their mid-60s on HD is 36%. Therefore the bypass graft should be selected in considering early results rather than

remote patency. In this sense, SVG should be selected more frequently in CABG for patients on HD, since it guarantees less invasiveness and easiness during operation. LITA should be selected as a graft for the left anterior descending artery, but it can be replaced by SVG in patients aged more than 70 and in emergency cases. The right internal thoracic artery (RITA) has a very important role as a graft inflow in cases with a calcified ascending thoracic aorta. In lengthy on-pump CABG procedures for patients on HD, the use of bilateral ITA sometimes causes excessive bleeding from the retrosternum. But this usually does not happen in off-pump CABG. Patients on HD often have calcification of the celiac artery and its branches. Therefore the right gastroepiploic artery (RGEA) has no superiority to SVG in CABG, especially for patients on HD, though it has an advantage as a pedicle graft.

High Risks in CABG

What are the high risks in CABG for patients on HD? Many reports argue the risks of these patients.[3–8] Most surgeons would answer this question by saying old age, emergency, low left ventricular function, vascular calcification, concomitant valve disease, reoperation. At present, CABG for normal octogenarians is not a high risk, but it would be if they are maintained on HD. They are usually in poor nutritional state and often have generalized peripheral arterial disease. Emergent operation remains risky, even in patients with normal renal function. Left ventricle function defined as less than 30% of left ventricular ejection function is also a risk, even in patients with normal kidney function. Calcification was already described. Minimally invasive direct coronary bypass (MIDCAB) and off-pump CABG via the left thoracotomy appear to be effective and safe for patients requiring a redo CABG.

Concomitant Valve Disease

The results of concomitant CABG and valve replacement are poor compared to those of isolated CABG or valve replacement.[5,9] A long cardiopulmonary bypass time to perform complicated procedures results in excessive water loading and may lead to respiratory failure and heart failure in patients on HD. Although hemofiltration devices and the administration of albumin solution into the cardiopulmonary bypass circuit are effective to prevent these complications,[10] they sometimes do not work well. This is caused by a malfunction of the vascular endothelium that allows a leak of blood plasma from the inside to the outside of the vessel. Normally, the endothelium prevents plasma leak-out, but this function is disturbed by preoperative heart failure or intraoperative hypotension. So-called difficult HD syndrome is characterized by intractable hypotension during HD, which results in incomplete blood purification and excessive water balance.[11] The causes of this syndrome include coronary disease, valvular disease, myocardial disease, and impaired vasomotor reaction. The results of CABG and/or valve replacement for patients with this syndrome are worst, so early indication is desired.

A combination of off-pump CABG and valve replacement may cut cardiopulmonary bypass time and prevent excessive volume loading.

Off-Pump or On-Pump?

As previously described, recent reports on CABG for patients on HD from Western countries show the superior early results of off-pump CABG compared to those of on-pump CABG.[3–5] These reports recommend the use of off-pump CABG for patients on HD. We must be prudent in judging whether off-pump CABG provides better results than on-pump CABG in these patients.

For example if an elective CABG is performed for a patient on HD, off-pump CABG should be selected because it is less invasive and creates less harmful stress than on-pump CABG in which CPB generates systemic inflammatory reaction and excessive fluid loading.

However, if the patient has a difficult coronary anatomy, e.g., calcification or advanced atherosclerosis, off-pump should not be selected because it does not provide a consistent, still-operative field that only cardioplegic cardiac arrest can provide. And if the patient is on HD with an unstable hemodynamic condition, off-pump should not be selected because it does not provide calm working conditions. On the other hand, if it is a redo case with a long duration of maintained HD, off-pump techniques, especially MIDCAB via the left thoracotomy, can make the CABG bleed less, allowing a performance that will be much easier.

In some papers, the number of bypass grafts for off-pump CABG was smaller than that of on-pump CABG. But the early results of off-pump CABG were superior to that of on-pump CABG. Is this because of technical limitations? Is this because of fewer patients requiring bypass grafts? Or is this because of high risk and the surgeon's intentional restriction to cut down surgical invasions? What would happen if the surgeon performed the same number of on-pump bypass grafts? We already know that leaving

the coronary with less than 75% stenosis in CABG does not induce any event in the early period. And it cannot be denied that incomplete revascularization will lead to late coronary event. Moreover, we know the coronary arteries in the posterior and inferior region are good targets for PCI. In CABG, for the high-risk patients on HD, it is most important to reduce the invasiveness to minimize mortality and morbidity.

CABG for patients on HD must be variably designed and individualized, since their conditions are various, e.g., weight, duration of HD, comorbid peripheral arterial disease, COPD, liver disease, and carotid stenosis, and also previous cerebral vascular accident apart from coronary anatomy and cardiac function.

Coexistence with PCI

Advancement in off-pump CABG enables surgical coronary intervention for patients on HD with high risks, e.g., advanced age, with multiple comorbidities, and/or poor left ventricle contraction. Especially, MIDCAB and off-pump CABG via the left thoracotomy are less invasive and can avoid excessive bleeding and sternal infection. But even these procedures are more invasive than PCI, since they cannot eliminate general anesthesia and surgical wounds. Actually, the patients can walk immediately after PCI is successfully performed. It is clear that the diabetic octogenarian on HD with one leg and no eyesight, for example, should have PCI rather than off-pump CABG, even if his coronary lesions are suitable for both CABG and PCI. On the other hand, a 40-year-old diabetic who started HD and has three diseased coronary arteries should have complete arterial revascularization with or without pump. All other patients on HD who are diagnosed to have indications of coronary intervention exist in the mainstream of patients between the extremes of these two symbolic patients.

The cardiac surgeon can choose the contents of CABG, e.g., techniques, target of coronary artery, number of grafts, characters of grafts, and the use of cardiopulmonary bypass. A selection of these elements is very important, since the patients on HD have various comorbidities and not merely a few weak points. The cardiac surgeon must detect some settle differences in each case and on some occasions must choose PCI rather than CABG if it is felt that the patient is too disabled and old to undergo even off-pump CABG, especially a MIDCAB.

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