Effects of the side of arteriovenous fistula on outcomes after coronary artery bypass surgery in hemodialysis-dependent patients

Yoshiyuki Takami, MD, Kazuyoshi Tajima, MD, Wataru Kato, MD, Kei Fujii, MD, Makoto Hibino, MD, Hisaaki Munakata, MD, and Yoshimasa Sakai, MD

Objective: The aim of the study was to determine whether using the in situ internal thoracic artery (ITA) graft ipsilateral to the arteriovenous fistula adversely affects the outcomes after isolated coronary artery bypass grafting (CABG) in the dialysis-dependent patients to answer the concerns of a possible steal and consequent myocardial ischemia.

Methods: We categorized 155 dialysis patients undergoing isolated CABG between January 1993 and December 2011 into 108 patients (70%, ipsilateral group) whose left anterior descending artery (LAD) was revascularized with the ITA ipsilateral to the arteriovenous fistula and 47 patients (contralateral group) whose LAD was grafted with the ITA opposite to the fistula, to compare their early and late outcomes.

Results: While 94% of the ipsilateral group had left fistula, 55% of the contralateral group had left fistulas. The LAD was grafted with the left ITA in 94% of the ipsilateral group, whereas it was grafted with left (49%) or right (51%) ITAs in the contralateral group. There was no significant difference in hospital mortality between the groups (ipsilateral 10.2% vs contralateral 10.6%). After follow-up for 55 $\pm$ 42 months, the overall survival (ipsilateral 58% vs contralateral 65% at 5 years) and cardiac event–free rates (ipsilateral 74% vs contralateral 68% at 5 years) were also similar between the groups by log-rank tests ($P = .90$ and $P = .07$).

Conclusions: Revascularization of the LAD using the in situ ITA graft ipsilateral to the arteriovenous fistula increases neither the operative mortality nor the risks of late death and cardiac events after isolated CABG in dialysis patients. (J Thorac Cardiovasc Surg 2014;147:619-24)

Cardiovascular disease is the principal cause of deaths in patients receiving hemodialysis (HD), more than two thirds of whom have symptomatic coronary artery disease.[1-3] Increased population with renal disease and extended life expectancy of HD patients result in more HD patients, especially with diabetes mellitus (DM) and advanced age, referred for coronary revascularization. For the HD patients with multivessel disease, coronary artery bypass grafting (CABG) may be selected on the basis of the guidelines and the previous studies demonstrating the superiority of CABG to percutaneous coronary intervention.[4-7] As well as in non-HD patients, in situ internal thoracic artery (ITA) grafting to the left anterior descending artery (LAD) improves survival and freedom from major adverse cardiac events (MACE) in HD patients.[8-11]

However, there are concerns of a possible steal in HD patients with a functioning ITA graft and an ipsilateral arteriovenous (AV) fistula or shunt of the upper extremity.[12-15] Although no reports definitively document a coronary artery steal with an ipsilateral AV fistula, there have been several reports of a steal and consequent myocardial ischemia during HD. The aim of the present study was to determine whether revascularization of the LAD using the in situ ITA graft ipsilateral to the AV fistula increases the risk of late death and MACE after isolated CABG in HD patients.

METHODS

The institutional review board approved this retrospective observational study, and the approval included a waiver of informed consent.

Study Patients

We performed isolated CABG in 159 patients with end-stage renal failure requiring HD (124 men and 35 women with a mean age of 63 $\pm$ 8 years) over an 18-year period between January 1993 and December 2011. They comprised 10.4% of all patients undergoing isolated CABG during the same period. They had a history of HD for 8.9 $\pm$ 8.1 years (range, 0.2-36 years). The major causes of end-stage renal failure included chronic glomerulonephritis (n = 32, 20%) and DM (n = 86, 54%), whereas the causes of disease in 17 (11%) patients were unknown.

Among them, after excluding 4 patients who did not undergo ITA grafting to the LAD, 155 patients were included in the study to compare 108 patients (69.7%, ipsilateral group) whose LAD was revascularized with the in situ ITA ipsilateral to the AV fistula and 47 patients (30.3%, contralateral group) whose LAD was revascularized with the in situ ITA opposite to the AV fistula.

CABG and Perioperative Renal Management

Surgical procedures of CABG were performed through a median sternotomy, after low-potassium (1.5 mEq/L) HD for the consecutive 2 days,

From the Department of Cardiovascular Surgery, Nagoya Daini Red Cross Hospital, Nagoya, Japan.

Disclosures: Authors have nothing to disclose with regard to commercial support.
Received for publication Oct 2, 2012; revisions received Dec 11, 2012; accepted for publication Jan 14, 2013; available ahead of print Feb 11, 2013.

Address for reprints: Yoshiyuki Takami, MD, Department of Cardiovascular Surgery, Nagoya Daini Red Cross Hospital, 2-9 Myouken-cho, Showa-ku, Nagoya 466-8650, Japan (E-mail: takami@nagoya2.jrc.or.jp).

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2013.01.031

Abbreviations and Acronyms

AV = arteriovenous
CABG = coronary artery bypass grafting
CI = confidence interval
CPB = cardiopulmonary bypass
DM = diabetes mellitus
HD = hemodialysis
HR = hazard ratio
ITA = internal thoracic artery
LAD = left anterior descending coronary artery
LVEF = left ventricular ejection fraction
MACE = major adverse cardiac events

except for emergency cases, to obtain serum potassium of 3.0 mEq/L.[16] In our strategy, in situ bilateral ITAs were preferred for revascularization of the left coronary territory whenever possible anatomically. Right ITAs were used to revascularize the LAD by crossing the midline if necessary. However, the use of bilateral ITAs was avoided in the HD patients with DM owing to the concerns of postoperative mediastinitis. The gastroepiploic artery (GEA) was mostly used for revascularization of the right coronary arteries with more than 90% stenosis. The coronary arteries, for which ITAs and gastroepiploic arteries were not used, were bypassed using saphenous veins anastomosed with the ascending aorta.

Since 2003, CABG was preferably performed on the beating heart with off-pump technique and cardiopulmonary bypass (CPB) was used if necessary. When CPB was used, we performed only hemofiltration during CPB, as in non-HD patients. By means of a hemoconcentrator incorporated into the CPB circuit, serum potassium less than 4.0 mEq/L and blood hemoglobin greater than 10.0 g/dL were maintained at the end of CPB to prevent subsequent hyperkalemia.[16] HD was resumed on the first postoperative day in most patients, except for those with hemodynamic instability or advanced hyperkalemia, who alternatively underwent continuous venovenous hemofiltration.

Data Collection and Follow-up

The ipsilateral and contralateral groups were retrospectively compared regarding the following primary end points: hospital mortality, late overall death, and late MACE. Hospital mortality was defined as death for any reason during the same hospitalization regardless of the length. Follow-up data were obtained from hospital charts or follow-up physicians and by means of direct telephone interviews with the patients or their families. The MACE was defined as cardiac death, myocardial infarction, hospital admission owing to congestive heart failure, and repeat revascularization. Cardiac death was defined as any death related to cardiac events, including sudden death.

Statistical Analysis

Continuous variables were expressed as means ± standard deviations and compared for differences between 2 groups with the Mann-Whitney *U* test. Categorical variables were expressed as percentages and analyzed using the χ^2 test or Fisher's exact test where appropriate. A multivariate logistic regression model was constructed to evaluate whether the side of the ITA was an independent predictor of hospital mortality. Long-term survival and MACE-free rate were estimated using the Kaplan-Meier method. Unadjusted comparisons of the 2 groups were made with a log-rank test. Cox proportional hazards models were also constructed to evaluate the effect of the side of ITA in the presence of potentially confounding covariates. All statistical analyses were performed with IBM SPSS Statics version 19 (IBM Corporation, Armonk, NY), calculating hazard ratios (HR), 95% confidence intervals (CI), and levels of statistical significance.

RESULTS

Preoperative and Operative Characteristics

As shown in Table 1, there were no significant differences in the patient characteristics, with the exception of the side of AV fistula, between the ipsilateral and contralateral groups. Whereas 94% of the ipsilateral group had left AV fistula, 55% of the contralateral group had left AV fistulas ($P < .001$). The locations and constructions of AV fistulas were similar between the 2 groups.

As shown in Table 2, the study patients underwent conventional (n = 55, 34%), on-pump beating heart (n = 31, 20%) or off-pump coronary artery bypass (n = 71, 46%) with distal anastomoses of 2.9 ± 0.9 per patient, with no significant differences between the 2 groups. With regard to the graft arrangements, in situ left ITAs were used in all patients of the ipsilateral group and were mainly grafted to the LAD. In contrast, left ITAs were used in 91% of the patients of the contralateral group and were mostly grafted to the LAD or left circumflex artery. Right ITAs were more frequently used in the contralateral group than the ipsilateral group (60% vs 24%; $P < .001$). Right ITAs were mainly anastomosed to the left circumflex artery in the ipsilateral group and to the LAD in the contralateral group. No free ITA grafts were used for the non-LAD coronary arteries. Consequently, bilateral in situ ITAs were used more frequently in the contralateral group than in the ipsilateral group (47% vs 24%; $P = .004$). There were no significant differences in the use of gastroepiploic artery and saphenous vein graft between the 2 groups.

Early Outcomes

Hospital mortality was 10.3% (16/155). The mortality improved over time: 16.2% (11/68) before 2003 and 5.7% (5/87) after 2003. The causes of hospital death included mediastinitis (n = 5), cardiac-related (n = 4), sepsis (n = 3), pneumonia (n = 2), gastrointestinal ischemia (n = 1), and stroke (n = 1). As shown in Table 3, there were no significant differences in the hospital mortality and the occurrence of postoperative complications, including mediastinitis and stroke, between the ipsilateral and contralateral groups. There were also no significant differences in the durations of intensive care unit stay and hospital stay between the survivors of the 2 groups.

A multivariate logistic regression analysis adjusting for 5 covariates, including left ventricular ejection fraction (LVEF) less than 40%, CPB use, bilateral ITA, and postoperative mediastinitis, revealed that ipsilateral ITA grafting to the LAD was no longer a predictor for hospital mortality (HR, 0.86; 95% CI, 0.49-1.50; $P = .59$). However, the variables of LVEF less than 40% (HR, 2.22; 95% CI, 1.23-7.12; $P = .03$) and CPB use (HR, 3.27; 95% CI,