Bilateral Internal Thoracic Artery Grafts in Hemodialysis: A Single-Center Propensity Score Analysis

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Background. **Clinical evidence comparing the surgical risk and long-term effectiveness of the bilateral internal thoracic artery (BITA) and single internal thoracic artery (SITA) for coronary artery bypass grafting (CABG) in hemodialysis patients is limited. We sought to clarify the short-term and midterm outcomes of CABG using BITA or SITA grafts in hemodialysis patients.**

Methods. **Between October 2000 and December 2015, 161 hemodialysis patients underwent isolated CABG by internal thoracic artery grafting; 67 received BITA grafts and 94 SITA grafts. Propensity score matching was used to compare 59 BITA and SITA patient pairs.**

Results. **BITA and SITA grafts resulted in comparable 30-day mortality (1.7% vs 0%, $p = 1.00$), incidence of deep sternal wound infection (5.1% vs 1.7%, $p = 0.62$), stroke (3.4% vs 3.4%, $p = 1.00$), and respiratory failure (8.5% vs 11.9%, $p = 0.75$). The Kaplan-Meier model showed the survival rate in the BITA and SITA groups was 83.4% ± 5.1% vs 87.0% ± 4.6% at 1 year, 69.1% ± 7.3% vs 68.5% ± 6.9% at 3 years, and 47.4% ± 10.45% vs 58.2% ± 8.1% at 5 years of follow-up, respectively. There were no statistical differences in survival ($p = 0.81$), freedom from cardiac death ($p = 0.51$), or freedom from cardiac events ($p = 0.85$).**

Conclusions. **CABG using BITA grafts showed no advantages in midterm outcome among hemodialysis patients; however, there were no adverse effects on perioperative morbidity or death. For hemodialysis patients with limited available conduits, BITA may be an important option for multivessel revascularization.**

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Graft design for coronary artery bypass grafting (CABG) in hemodialysis patients is often challenging. On the one hand, a radial artery graft is not feasible after vascular access operations for hemodialysis, and a saphenous vein graft (SVG) is often unavailable because of peripheral artery disease (PAD). On the other hand, use of the bilateral internal thoracic artery (BITA) can lead to deep sternal wound infection (DSWI) and high mortality rates because hemodialysis patients are an immune-compromised population [1, 2] and many are diabetic [3].

In the general population, use of a BITA graft for CABG improves long-term survival compared with the single internal thoracic artery (SITA), as demonstrated in many studies [4–10]. Use of SITA grafts improves long-term survival in hemodialysis patients compared with the use of SVGs [11, 12]. However, the long-term benefit of BITA grafting in hemodialysis patients is not clear. In addition, whether the use of BITA grafts increases surgical death and morbidity, such as DSWI, compared with SITA grafts is unknown. The aim of this study was to clarify the short-term and midterm outcomes of BITA grafting in hemodialysis patients compared with SITA grafting.

Patients and Methods

This was a retrospective, observational, cohort study of data collected from 2,254 consecutive patients undergoing isolated CABG at our hospital between October 2000 and December 2015. Of those, 183 were hemodialysis patients. The exclusion criteria were nonuse of the internal thoracic artery (ITA) (n = 5) and acute myocardial infarction (n = 18). After application of the exclusion criteria, 161 patients were selected. The IMS Katsushika Heart Center Institutional Review Board approved the study. All of the patients admitted to the study gave their informed consent for the scientific analysis of their data in an anonymous form.

The primary study end point was death (all causes). The secondary end points were cardiac death and cardiac events (cardiac death, acute myocardial infarction, coronary intervention, and congestive heart failure requiring hospitalization). Early outcomes investigated included 30-day death, the incidence of stroke, DSWI, and respiratory failure.

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Abbreviations and Acronyms

- BITA = bilateral internal thoracic artery
- BMI = body mass index
- CABG = coronary artery bypass grafting
- DSWI = deep sternal wound infection
- GEA = right gastroepiploic artery
- ITA = internal thoracic artery
- LAD = left anterior descending artery
- LITA = left internal thoracic artery
- LVEF = left ventricle ejection fraction
- PAD = peripheral artery disease
- PCI = percutaneous coronary intervention
- RITA = right internal thoracic artery
- SITA = single internal thoracic artery
- SMD = standardized mean difference
- SVG = saphenous vein graft

Surgical Technique

The ITA and right gastroepiploic artery (GEA) were harvested in a skeletonized fashion by using an electric scalpel. Most patients underwent off-pump coronary artery bypass, except for 11 patients (6.8%) who were hemodynamically unstable. Table 1 reports the distribution of the grafts. Graft selection depended essentially on the coronary anatomy. Skeletonized harvesting of BITA was performed on patients despite the presence of diabetes mellitus or obesity. The left anterior descending artery (LAD) was always revascularized using an ITA, and the left circumflex coronary artery territory was revascularized using a second ITA. SVGs were occasionally used for patients with moderate coronary artery stenosis, which could compete with preserved native flow.

In patients who received BITA grafting, the in situ right ITA was anastomosed to the LAD, and the in situ left ITA was anastomosed to the circumflex artery. When the right ITA was not long enough to reach the LAD, it was grafted to the circumflex artery through the transverse sinus, or as a composite Y graft from the left ITA, and the left ITA was grafted to the LAD. The selection of which side ITA was used was not affected by the type or location of the dialysis fistula. In cases of severe stenosis (≥90%) in the right coronary artery territory, revascularization was completed using an in situ GEA; otherwise, a SVG or a free GEA was used. Considering arterial venous fistula for hemodialysis, the radial artery was not used.

One experienced surgeon performed the operation in 107 patients (66.5%), and the remaining 54 patients (33.5%) were operated on by other surgeons under the experienced surgeon's management.

Table 1. Distribution of the Grafts Before and After Matching

Variable[a]	LITA	RITA	GEA	SVG
Before matching				
BITA group (n = 67)	67 (100)	67 (100)	5 (7.5)	35 (52.5)
LAD	33	39	0	0
LCx	33	21	0	8
RCA	2	8	5	29
SITA group (n = 94)	90 (95.7)	7 (7.4)	21 (22.3)	56 (60.0)
LAD	88	5	0	1
LCx	2	1	5	36
RCA	0	1	17	32
After matching				
BITA group (n = 59)	59 (100)	59 (100)	4 (6.8)	29 (49.2)
LAD	28	36	0	0
LCx	30	16	0	8
RCA	2	7	4	23
SITA group (n = 59)	57 (96.6)	4 (6.8)	17 (28.8)	38 (64.4)
LAD	55	3	0	1
LCx	2	0	3	27
RCA	0	1	14	21

[a] Values are number (%).

BITA = bilateral internal thoracic artery; GEA = right gastroepiploic artery; LAD = left anterior descending artery; LCx = left circumflex artery; LITA = left internal thoracic artery; RCA = right coronary artery; RITA = right internal thoracic artery; SITA = single internal thoracic artery; SVG = saphenous vein graft.

Statistical Analysis

Demographic and clinical data are presented as frequency distributions and percentages. Values of continuous variables are expressed as the mean ± SD. Differences between the BITA and SITA groups were compared with the χ^2 test or the Fisher exact test for categoric variables and the *t* test or Mann-Whitney *U* test for continuous variables. To reduce the effect of treatment selection bias and potential confounding in this observational study, we adjusted differences in the baseline characteristics of patients using propensity score matching. The predicted probability of BITA use was calculated by fitting a logistic regression model using all clinically relevant variables, as summarized in Table 2. The patient pairs, who had BITA and SITA grafts, were derived using 1:1 nearest-neighbor matching with a ± 0.05 caliper and no replacement. We used the standardized mean difference to measure covariate balance, by which an absolute standardized mean difference above 10% is assumed to represent a meaningful imbalance.

After propensity score matching was performed, differences between the two groups were assessed using the paired *t* test for continuous variables and the McNemar test for categoric variables. Kaplan-Meier estimates were used to plot the rates of midterm adverse events (all-cause death, cardiac death, cardiac event), and a log-rank test was used to assess differences between the risk curves. The hazard ratios and 95% confidence intervals for the association between BITA grafting and all-cause death and cardiac-related death were estimated using the Cox proportional hazard models in matched cohorts. Univariate and multivariate logistic regression analyses were performed to determine independent predictors of DSWI in the unmatched and matched cohorts. Variable selection was based on clinical knowledge. Statistical