Bilateral internal thoracic artery use for dialysis patients: does it increase operative risk?

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Bilateral Internal Thoracic Artery Use for Dialysis Patients: Does It Increase Operative Risk?

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Background. **The efficacy and risk of using the bilateral internal thoracic artery (BITA) for coronary artery bypass grafting in dialysis patients is virtually unknown.**

Methods. **Twenty-five patients on dialysis who underwent coronary artery bypass grafting using the BITA were retrospectively studied (BITA group). For comparison purposes, 52 patients on dialysis who underwent coronary artery bypass grafting using the left ITA were selected (LITA group).**

Results. **No wound healing problems occurred in the BITA group. Mean postoperative bleeding volume was 1,427 ± 808 mL and 800 ± 508 mL in the BITA and LITA groups, respectively ($p = 0.00009$). Blood transfusions for the BITA and LITA groups required an average of 6.8 and 6.2 units of packed red blood cells, respectively, with no significant difference. Five patients in the BITA group (20%) showed severe atherosclerotic deterioration of the ascending aorta, precluding clamping. Hospital mortality was 4% (1 of 25 patients) in the BITA group and 7.7% (4 of 52 patients) in the LITA group, with no significant difference ($p = 0.49$).**

Conclusions. **In patients on dialysis, especially those with severe atherosclerotic or calcified deterioration of the ascending aorta, coronary artery bypass grafting using BITA grafting (arterial in situ conduits) may offer the easiest and most suitable solution without increased operative risk.**

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The internal thoracic artery (ITA) is considered to provide an excellent long-term patency rate, and using it as a bypass to the left anterior descending coronary artery improves long-term survival after coronary artery bypass grafting (CABG) [1, 2]. The extended use of the ITA became widespread during the mid-1980s when numerous investigators advocated complex ITA procedures [3–5]. However, sternal wound problems, typically infection and bleeding due to the use of bilateral ITA (BITA), are still unsolved. Some researchers recommended avoidance of its use in obese patients [6], especially in diabetics [6, 7].

Patients with chronic renal failure on maintenance dialysis often have associated comorbid disorders that predispose them to increased operative morbidity and mortality: inability to excrete certain medications, platelet dysfunction, and susceptibility to infection [8–11]. It would seem that the use of BITA for patients on dialysis would be more likely to lead to sternal wound complications and subsequent high mortality, but up to now, no reports on this subject have been published. The purpose of this report is to analyze whether CABG using BITA in dialysis patients increases operative risk.

Material and Methods

Eighty-two patients with chronic renal failure on maintenance dialysis required isolated CABG between July 1988 and July 1999 at Kumamoto Central Hospital. Of these patients, 25 who underwent CABG using the BITA were retrospectively studied (the BITA group). There were 20 (80%) male patients, with a mean age of 64 ± 7.7 years (42 to 78 years). Patient profiles are summarized in Table 1. Patients had been on dialysis for at least 1 month, with a mean duration of 8.6 ± 6.3 years (0.25 to 22 years) before CABG. With the exception of 2 patients who were maintained on continuous ambulatory peritoneal dialysis, all were on hemodialysis. Twenty patients (80%) were on dialysis as a result of diabetes mellitus or chronic glomerulonephritis. Eleven patients (44%) were diabetic, and of these patients, 6 (24%) were being treated with insulin.

Fifty-two dialysis patients who had undergone CABG by single ITA were selected for comparison purposes. The left ITA (LITA) was used in all patients, and except for 2 patients, the recipient native coronary artery was the left anterior descending coronary artery (LITA group). The parameters listed in Table 1 showed no significant difference between the two groups. The remaining 5 patients underwent CABG using only saphenous vein grafts, and were thus excluded from this study.

Tables 2 and 3 summarize the clinical, angiographic, and operative characteristics of the patients. In all the patients, myocardial ischemia was severe enough to interfere with maintenance dialysis. The mean preoperative left ventricle ejection fraction estimated by ultrasonography was 66% ± 12% and 67% ± 16% in the BITA and LITA groups, respectively, without significant difference between the two groups. The mean graft number

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Table 1. Patient Profile

Characteristics	BITA Group	LITA Group
No. of patients	25	52
Male sex	20	42
Age (y)		
Mean	64 ± 7.7	64 ± 9.8
Range	42–78	37–81
Preoperative dialysis		
Duration (y)		
Mean	8.6 ± 6.3	6.4 ± 5.5
Range	0.25–22	0.25–20
Type		
Hemodialysis	23	51
CAPD	2	1
Causes of CRF		
Diabetes mellitus	11 (44%)	21 (40%)
Chronic glomerulonephritis	9 (36%)	21 (40%)
Other	5 (20%)	10 (19%)
Associated disease		
Hypertension	21 (84%)	38 (73%)
Diabetes mellitus	11 (44%)	21 (40%)
Insulin used	6 (24%)	12 (23%)
Hyperlipidemia	9 (36%)	14 (27%)
PVD of the lower limb	5 (20%)	10 (19%)
Cerebrovascular disease	5 (20%)	8 (15%)

p = not significant.

BITA = bilateral internal thoracic artery; CAPD = continuous ambulatory peritoneal dialysis; CRF = chronic renal failure; LITA = left internal thoracic artery; PVD = peripheral vascular disease.

was 4.1 ± 1.2 and 3.3 ± 1.1 in the BITA and control groups, with a significant difference of $p = 0.0048$.

Table 4 illustrates the bypass procedures. The combination of both ITAs to the recipient coronary artery was the LITA to the left anterior descending coronary artery and the right ITA (RITA) to segment 12 or 14 of the circumflex coronary artery in 20 patients, and LITA to the circumflex coronary artery and the RITA to the left anterior descending coronary artery in 5 patients.

Patients were on dialysis according to the normal method the day before the operation, and this method was reinstituted the day after operation. Nafamostat mesilate instead of heparin was selected as the anticoagulant agent for the first postoperative hemodialysis. Postoperative management in the intensive care unit was similar to that for control patients, but taking particular care to maintain adequate cardiac output of more than 2.5 $L \cdot min^{-1} \cdot m^{-2}$.

Table 2. Clinical and Angiographic Characteristics

Characteristics	BITA Group	LITA Group
Preoperative ischemia unstable angina	14 (56%)	31 (60%)
Functional NYHA classification ≧ III	16 (64%)	39 (75%)
Anginal CCS classification ≧ III	15 (60%)	39 (75%)
Old myocardial infarction	13 (52%)	20 (38%)
Three-vessel disease	19 (76%)	37 (71%)
Left main trunk stenosis ≧ 50%	13 (52%)	16 (31%)

p is not significant.

BITA = bilateral internal thoracic artery; CCS = Canadian Cardiovascular Society; LITA = left internal thoracic artery; NYHA = New York Heart Association.

Table 3. Surgical Procedures

Procedure	BITA Group	LITA Group	p Value
Emergent operation	2 (8%)	6 (12%)	NS
Preoperative IABP support	0 (0%)	3 (6%)	NS
Aortic cross-clamp time (min)	73 ± 17	79 ± 23	NS
CPB time (min)	115 ± 20	126 ± 39	NS
No. of grafts/patient	4.1 ± 1.2	3.3 ± 1.1	0.0048

BITA = bilateral internal thoracic artery; CPB = cardiopulmonary bypass; IABP = intraaortic balloon pumping; LITA = left internal thoracic artery; NS = not significant.

The surgical technique was similar to that used in renally sufficient patients. Cardiopulmonary bypass induced mild hypothermia to 32°C to 34°C at flow indexes of 2.2 to 2.4 $L \cdot min^{-1} \cdot m^{-2}$ to maintain the perfusion pressure above 70 mm Hg. Cardioprotection was accomplished following techniques similar to those patients who were not on dialysis by initial crystalloid cardioplegia followed by subsequent cold blood cardioplegia every 30 minutes and added topical cooling, but differing from control patients by diverting the coronary sinus effluent into the hemofilter connected in parallel to the extracorporeal circuit, to provide large volume hemofiltration with K^+ free replacement solution during cardiopulmonary bypass. Patients were weaned off cardiopulmonary bypass with a hematocrit of more than 30% achieved by packed red cell transfusion and return of mediastinal blood drainage after cell washing and packing, and serum K^+ of less than 4.0 mEq/L.

The ITA was harvested with the use of low-current electrocoagulation and metallic clips (Ethicon, Inc, Somerville, NJ), with both pleural cavities being opened. The chest tube was inserted into the opened pleural cavity for drainage. Wound closure was performed using the same method in all patients: sternal rewiring and a subcutaneous closure through several layers using a Dexon running suture.

The need for technical modifications to minimize atheroembolization was determined by preoperative computed tomography and intraoperative epiaortic ultrasonography of the ascending aorta. Five patients in the

Table 4. Bypass Procedures

BITA Group (n = 25)		LITA Group (n = 52)	
BITA + (SVG)	14	LITA + (SVG)	38
BITA + GEA + (SVG)	11	LITA + GEA + (SVG)	14

BITA = bilateral internal thoracic artery; GEA = gastroepiploic artery; LITA = left internal thoracic artery; SVG = saphenous vein graft.

BITA group (20%) showed severe atherosclerotic deterioration in the ascending aorta, which precluded clamping under ventricular fibrillation or while beating on pump (7 patients, 13%, in the LITA group, without significant difference).

The operation was considered emergent when operation was performed nonelectively within 24 hours of the decision to proceed with CABG regardless of hemodynamic status. Hospital mortality included deaths occurring within 30 days of CABG or during the same hospitalization period. All operations were performed by the same surgeon, and both groups were designated at the same time in 1988. The BITA was selectively used for the patients with optimal target circumflex coronary artery of RITA.

Statistical Analyses

Fisher's exact test was used for the nonparametric variables, and the unpaired *t* test for continuous variables; a p value of less than 0.05 was considered to be statistically significant. All data are presented as mean ± standard deviation unless stated otherwise.

Results

Sternal Wound Complications

No wound healing problems occurred in the BITA group. In the LITA group, 2 patients needed resuturing due to skin layer dehiscence, but no growth of organisms was detected in culture.

Bleeding Complications

The mean postoperative bleeding volume from the chest tube was 1,427 ± 808 mL and 800 ± 508 mL in the BITA and LITA group, respectively, with a significant difference of $p = 0.00009$. One patient in each group required reexploration due to excess bleeding. The bleeding point of the patient in the BITA group was the branch of the saphenous vein graft. Apart from this individual, only 1 patient in the BITA group required treatment with blood platelet. Other blood replacements required by the BITA and LITA groups was an average of 6.8 and 6.2 units of packed red blood cells, respectively, with no significant difference.

Respiratory Complications

The mean postoperative ventilation time was 19.2 ± 10 hours and 18.0 ± 10 hours in the BITA and LITA group, respectively, with no significant difference ($p = 0.63$). Two patients in the LITA group who needed extended ventilation support caused by low output syndrome were excluded from this analysis. No patients in the BITA group required reintubation due to respiratory failure. One patient in the LITA group required reintubation.

Other Complications

Six other nonlethal complications occurred in the BITA group: pleural effusion required puncture in 2 patients, temporary neurologic complication of disorientation in 1, amputation of lower limb due to ischemia in 1, paralytic ileus in 1, and intraaortic balloon pumping insertion in 1 patient. The last patient was a 76-year-old woman who received gastroepiploic artery to the large right coronary artery with severe ostial stenosis. After weaning from cardiopulmonary bypass, the patient suffered acute deterioration of right ventricular wall motion and complete atrial–ventricular block. Intraaortic balloon pump was immediately inserted, because hypoperfusion of the gastroepiploic artery was suspected. Hemodynamics remarkably improved with only intraaortic balloon pump support, therefore supplemental saphenous vein graft for the right coronary artery was not required. Since this event, this patient's postoperative course has been good.

Hospital Mortality

Hospital mortality was 4% (1 of 25 patients) in the BITA group and 7.7% (4 of 52 patients) in the LITA group, respectively, with no significant difference ($p = 0.49$). One 67-year-old man in the BITA group died on the 45th postoperative day from intestinal necrosis after ventricular fibrillation due to digitalis intoxication. Four patients in the LITA group died. One 59-year-old man who underwent CABG with circulatory arrest to remove mobile plaque in the ascending aorta died 10 days after operation from multiorgan failure caused by intestinal necrosis. Two patients died from ventricular fibrillation, 1 on the 14th postoperative day from hypokalemia, and the other patient on the seventh postoperative day for unknown reasons. The fourth death was on the 32nd postoperative day from pneumonia after extended ventilation in response to low output syndrome.

Early Angiographic Results

Postoperative coronary angiography was performed in 20 patients (80%) 2 to 3 weeks after operation. The 5 patients who were not restudied included 1 hospital death and 4 patients whose ascending aorta showed severe atherosclerotic deterioration. In the 20 patients, a total of 81 conduits were grafted, with a patency rate of 99% (80 of 81 patients). One saphenous vein graft became occluded, but the arterial grafts, which included 20 LITA, 20 RITA, and 9 gastroepiploic artery were entirely patent without any stenotic findings.

Comment

The superiority of ITA grafts over venous conduits has been documented [1, 2]. In an effort to encourage the use of this superior conduit, a number of institutions have reported the usefulness of BITA grafts [3–5]. Our institution has also promoted the use of the BITA for CABG and has already reported successful results [12, 13]. On the other hand, the use of the BITA increases the risk of sternal wound complications. Some investigators [6, 7, 14] report that diabetes mellitus is a major predictor of sternal infection in patients undergoing BITA grafting, and recommend avoidance of this method in diabetic patients.

Poor wound healing and increased bleeding as a result

of the use of the ITA were previously assumed to rule out this technique in renal dialysis patients. In 1990, Blakeman and colleagues [15] reported on ITA revascularization in patients on long-term renal dialysis. They made a comparison between two groups: SVG only and ITA in combination with SVG. In this study, we compared the early results of patients on dialysis who had undergone single ITA grafting and BITA grafting, and analyzed whether the use of the BITA increases the incidence of complications including bleeding, sternal wound infection, and operative risk.

The chest tube drainage volume was greater in the BITA group before they were removed. However, requirement for postoperative blood transfusion was no greater than that of the LITA group and platelet transfusion for hemostasis was needed in only 2 patients in the BITA group. No patient in the BITA group needed reexploration due to bleeding from the BITA or dissected surface. Reexploration was needed in only 1 patient due to bleeding from a branch of the saphenous vein graft.

No wound healing problems occurred in the BITA group, which included 11 diabetic patients (insulin used in 6 patients). When harvesting the ITA, the pleural cavity was routinely opened to provide the shortest route from the ITA origin to the recipient coronary artery. The bilateral pleural cavities of all patients in the BITA group were opened. However, the mean postoperative ventilation time did not differ from that of the LITA group, and no respiratory complications occurred in the BITA group. No extended ventilation support (> 48 hours) was required.

One patient in the BITA group died from arrhythmia caused by digitalis intoxication. Hospital mortality was 4% with no statistical difference between the BITA group and the LITA group (7.7%; $p = 0.50$). Although it is difficult to make a direct comparison between the two groups because the backgrounds of both groups were not completely matched, it is clear from our data that BITA grafting does not increase hospital mortality in dialysis patients.

We did not use any special techniques, but ensured the following: (1) minimum hemostasis of parasternal fatty tissue by electrocoagulation; (2) minimum use of bone wax on bone marrow; (3) protection of the periosteum while harvesting the ITA; (4) complete hemostasis of the ITA using metallic clips instead of electrocoagulation; and (5) maintenance of cardiac output at a high level (cardiac index, > 2.5 L $\cdot$ min^{-1} $\cdot$ m^2) during the postoperative period.

Some researchers recommend dialysis more than 24 hours before the cardiopulmonary bypass procedure [16], but we believe that it is best to dialyze as close to the procedure as possible. Although some investigators advocate the use of intraoperative hemodialysis [17], we chose intraoperative hemofiltration for reasons of simplicity in achieving control of water and electrolyte (mainly K^+) balance until maintenance hemodialysis was resumed on the first postoperative day. This was possible in all patients, and did not generate any untoward hemodynamic sequelae.

Peritoneal dialysis offers the advantages of avoiding hemodynamic instability and the risks of bleeding associated with the use of heparin for hemodialysis, as well as the logistic advantage of not requiring a specialized technician [18], but it precludes the use of the gastroepiploic artery as a second arterial graft. In our experience, except for patients with severely depressed cardiac function, with careful observation hemodialysis could be safely performed in most patients, but it is important to remember that frequent arteriovenous access provides a potential for endocarditis [11, 19].

Five patients (20%) in the BITA group and 7 patients (13%) in the LITA group required modifications to the operative procedure due to severe calcification of the ascending aorta, confirming the reported higher incidence of coronary and extracoronary calcific arterial lesions [19, 20] in dialysis patients. The use of in-situ arterial conduits facilitated revascularization without the need to manipulate the ascending aorta under induced ventricular fibrillation, but saphenous vein CABG would require circulatory arrest.

In conclusion, CABG using BITA for patients on dialysis was safely performed without sternal wound healing, respiratory, or any other complications. This study did not compare the long-term outcomes between patients who had received two arterial grafts and those with one arterial graft. However, for patients on dialysis, especially those with severe atherosclerotic or calcified deterioration of the ascending aorta, CABG using BITA (arterial in-situ conduits) may offer the simplest and most suitable approach.

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