Long-term outcomes of patients with diabetes receiving bilateral internal thoracic artery grafts

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Objectives: Bilateral internal thoracic artery (BITA) grafting in patients with diabetes are controversial because of increased risk of sternal infection. On the other hand, patients with diabetes may benefit from BITA grafts because of the associated improved survival. This study evaluated factors affecting early and long-term outcomes for better selection of patients with diabetes for BITA grafts.

Methods: Between 1996 and 2006, 69 patients with insulin-treated diabetes and 732 with orally treated diabetes received isolated skeletonized BITA grafts. Of these patients, 338 were younger than 65 years, 322 were between 65 and 74 years old, and 141 were 75 years or older.

Results: Operative mortality was lower than logistic EuroSCORE–calculated mortality (2.9% vs 7%, $P < .001$). Predictors of increased mortality were critical preoperative state ($P < .001$) and age ($P = .008$). There were 30 cases of sternal infection (3.7%); predictors were reoperation ($P < .001$), peripheral vascular disease ($P = .009$), obesity ($P = .012$), chronic lung disease ($P = .009$), and female sex ($P = .020$). Mean follow-up was 8.4 ± 4 years. Kaplan-Meier 10-year survivals were 75%, 59%, and 39% for patients younger than 65, 65 to 74, and at least 75 years, respectively ($P < .001$). They were better than corresponding Charlson comorbidity index–predicted survivals (36%, 10%, and 3%, respectively; $P < .001$). Predictors of decreased survival were age ($P < .001$), congestive heart failure ($P < .001$), and peripheral vascular disease ($P < .001$). Off-pump surgery was independently associated with better long-term survival ($P = .003$).

Conclusions: BITA grafts are safe in patients with diabetes. Favorable short- and long-term outcomes outweigh increased sternal infection risk. (J Thorac Cardiovasc Surg 2013;146:586-92)

Ischemic heart disease is the leading cause of death in patients with diabetes mellitus.[1] Patients with diabetes have a tendency toward development of multivessel disease, and their prognosis is worse than that of patients without diabetes. More and more patients with diabetes are being referred for coronary artery bypass grafting (CABG) or for angioplasty for revascularization of the coronary system,[2] which makes them a large proportion of the patients undergoing these procedures.[3]

Surgical revascularization of the left anterior descending artery with the internal thoracic artery (ITA) is still the only proven method of improving event-free survival in patients with multivessel disease.[4,5] Long-term follow-up of the Bypass Angioplasty Revascularization Investigation study showed that in patients diabetes with multivessel disease, CABG was associated with significantly lower rates of sudden death and myocardial infarction–related death[6] than was angioplasty. Left anterior descending revascularization in that study was an independent predictor of long-term survival.

Similar findings were reported later in the Arterial Revascularization Therapy study.[7] In that study, the 3-year survival of patients with diabetes undergoing CABG was higher than that of patients with diabetes undergoing coronary angioplasty with bare-metal stents.

Bilateral ITA (BITA) grafting is associated with improved survival relative to CABG with single ITA grafts and saphenous vein grafts (SVGs).[7] In addition to improved survival, patients with BITA had better event-free survival and reduced occurrence of reinterventions.[7] Despite the improved long-term outcomes in patients without diabetes, the application of this technique in those with diabetes remains controversial because of the increased risk of sternal infection and subsequent lethal mediastinitis as a result of sternal devascularization.[8] Collateral circulation to the sternum can be partially preserved if the conduit is harvested as a skeletonized conduit.[9] Dividing the collateral branches with hemostatic clips and scissors enables maintenance of collateral perfusion from the intercostal or the muscular branches, which are usually destroyed by the use of the cautery and the dissection of the conduit as a pedicle.

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Abbreviations and Acronyms

BITA = bilateral internal thoracic artery
CABG = coronary artery bypass grafting
CCI = Charlson comorbidity index
CI = confidence interval
COPD = chronic obstructive pulmonary disease
HR = hazard ratio
ITA = internal thoracic artery
OPCAB = off-pump coronary artery bypass grafting
OR = odds ratio
PVD = peripheral vascular disease
RCA = right coronary artery
SVG = saphenous vein graft

The lack of complete sternal devascularization in the first days after the operation can also form the basis for improved sternal wound healing in patients with diabetes[9]; in our experience, however, occurrence of sternal wound infection was still higher in patients with diabetes than in those without, and diabetes has been found to be a significant predictor of sternal wound infection in multivariable logistic regression analysis.[10] Despite the increased risk of sternal complications, patients with diabetes may still benefit from BITA grafting because of their accelerated atherosclerosis and the increased propensity toward SVG failure.[4,11]

The purpose of this study was to evaluate early and long-term outcomes of skeletonized BITA grafting in patients with diabetes to determine whether potential survival benefit outweighs the increased risk of sternal infection. We also wished to evaluate preoperative and operative factors affecting early and long-term outcomes to improve selection of patients with diabetes to receive BITA grafts.

MATERIALS AND METHODS

From January 1996 to December 2006, a total of 801 consecutive patients with diabetes underwent myocardial revascularization with BITAs that were dissected as skeletonized arteries.[9] They comprised 30.6% of the 2615 isolated BITA grafting procedures performed in the Tel Aviv Sourasky Medical Center during this time. Preoperative and operative patient data were collected from the hospital medical records with institutional review board approval. To evaluate the effects of age on early and long-term outcomes, patients were stratified into 3 age groups: 64 years old or younger, between 65 and 74 years old, and 75 years or older. To evaluate the learning curve effect, patients were stratified according to their operative date into 2 groups: early (1996-1999) and late (2000-2006).

Expected operative mortality was calculated with the logistic EuroSCORE[12] and compared with the observed early mortality. Expected midterm and long-term mortalities without operation were calculated with the Charlson comorbidity index (CCI)[13] and compared with the expected survival of the Israeli population of the same age and sex distribution[14] and with the Kaplan-Meier actuarial survival. Follow-up was obtained with the Israeli National Registry database and a telephone questionnaire.

Surgical Techniques

Operations were performed with standard cardiopulmonary bypass or as off-pump CABG (OPCAB). Myocardial preservation during cardiopulmonary bypass involved intermittent, antegrade or retrograde blood cardioplegia (30°C-32°C). Coronary stabilization during OPCAB was facilitated with CTS stabilizers (Guidant, Indianapolis, Ind) or the Octopus system (Medtronic, Minneapolis, Minn). ITAs were mobilized from the chest wall as skeletonized vessels.[9,15] In most cases, BITAs were used to graft the left coronary system, the myocardial territory supplied by the left anterior descending and circumflex arteries. Two arrangements were implemented: a free right ITA attached proximally end to side on the left ITA in a T-graft configuration (composite T-graft) and an in situ BITA with an anteaortic crossover right ITA. The choice of configuration was determined by previously detailed technical considerations.[15] The type of conduit selected for right coronary artery (RCA) grafting was not related to the configuration of the ITAs. Our strategy was to use right ITAs, right gastroepiploic arteries, and radial arteries as grafts to the RCA branches only in the presence of a significant stenosis (>80%).[16] When the RCA system was unsuitable for arterial grafting, such as in cases with a potential for high competitive flow in the RCA, we selected SVG as the conduit for revascularization of the RCA.

To decrease the risk of spasm of the arterial grafts, all patients were treated with a high-dose intravenous infusion of isosorbide dinitrate (Isoket; 4-20 mg/h) during the first 48 postoperative hours. Calcium-channel blockers (diltiazem hydrochloride [INN diltiazem]; 90-180 mg/d orally) were given to patients operated on using right gastroepiploic artery or radial artery from the second postoperative day for at least 3 months.[15]

Definition of Terms and Data Collection

Patient data were analyzed according to American College of Cardiology and American Heart Association Clinical Data Standards.[17]

Chronic renal failure was diagnosed if the creatinine level exceeded 1.8 mg/dL. Peripheral vascular disease (PVD) included all symptomatic and asymptomatic extracoronary arteriopathy. Cerebrovascular disease included history of any previous cerebrovascular event, with or without permanent neurologic damage.

Our definition of an emergency operation was based on the Society of Thoracic Surgeons guidelines and included patients operated on within 24 hours of cardiac catheterization, with ongoing angina, acute evolving myocardial infarction, pulmonary edema, or cardiogenic shock.[18] Patients who needed emergency surgery and were not stabilized after intra-aortic balloon counterpulsation were usually operated on with a single ITA combined with SVGs and therefore were not included. A perioperative myocardial infarction was defined by the appearance of new Q waves in the electrocardiogram associated with elevated levels of creatine kinase MB fraction (>50 mU/mL). A cerebrovascular accident was defined as a new permanent neurologic deficit with computed tomographic evidence of cerebral infarction. Deep sternal infection was defined as the sum of deep infection and late dehiscence requiring sternectomy.

Statistical Analysis

Data are expressed as the mean ± SD or as a proportion. The χ^2 test and 2-sample t tests were used to compare discrete and continuous variables, respectively. Multivariable logistic regression analysis was used to predict early mortality and early morbidity events by various risk factors. The odds ratios (ORs) with 95% confidence intervals (CIs) are given. Postoperative survivals of each age group are expressed by the Kaplan-Meier method, and survival curves were compared with the log-rank test. The Cox proportional hazard model was used to evaluate the influence of preoperative variables and operative data on late and overall mortalities. A Cox model was used to compare adjusted survivals between the various age groups after controlling for differences between groups in preoperative and operative

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