Should Bilateral Internal Thoracic Artery Grafting Be Used in Patients With Diabetes Mellitus?

Dmitry Pevni, MD,* Benjamin Medalion, MD,* Rephael Mohr, MD, Yanai Ben-Gal, MD, Adam Laub, MD, Avner Nevo, MD, Amir Kramer, MD, Yosef Paz, MD, and Nachum Nesher, MD

Department of Cardiothoracic Surgery, Tel Aviv Sourasky Medical Center, and Department of Cardiothoracic Surgery, Rabin Medical Center, PetahTikva, Faculty of Medicine, Tel Aviv University, Israel

Background. **Bilateral internal thoracic artery (BITA) grafting in patients with diabetes mellitus is controversial because of a higher risk for sternal infection. The purpose of this study is to compare the outcome of BITA grafting to that of single ITA (SITA) grafting in patients with diabetes.**

Methods. **Between 1996 and 2010, 964 diabetic patients with multivessel disease who underwent primary coronary artery bypass graft surgery with BITA were compared with 564 patients who underwent coronary artery bypass graft surgery with SITA and saphenous vein grafts.**

Results. **The SITA patients were older, more often female, more likely to have chronic obstructive pulmonary disease, ejection fraction 30% or less, insulin-dependent diabetes, recent myocardial infarction, renal insufficiency, peripheral vascular disease, and emergency operation. The BITA patients more often underwent coronary artery bypass graft surgery with three or more grafts. The two groups had similar operative mortality, 2.6% BITA versus 3.0% SITA, and sternal infection, 3.1% versus 3.9%, respectively. The mean follow-up was 12.2 ± 4.3 years. Unadjusted Kaplan-Meier 10-year survival of the BITA group was better than that of the SITA group (65.3% ± 3.1% versus 55.5% ± 4.5%, respectively; $p = 0.004$), After propensity score matching (490 well-matched pairs), Kaplan-Meier 10-year survival was not significantly different between the matched groups; however, the Cox-adjusted survival of the BITA patients was better (hazard ratio 0.729, 95% confidence interval: 0.551 to 0.964, $p = 0.027$).**

Conclusions. **The findings of this large cohort study suggest that the long-term outcome of patients with diabetes and multivessel disease who undergo BITA grafting is better than that of diabetic patients who undergo coronary artery bypass graft surgery with SITA and saphenous vein grafts.**

(Ann Thorac Surg 2016;■:■–■)

The outcome of patients with diabetes mellitus undergoing myocardial revascularization procedures (coronary artery bypass graft surgery [CABG] or percutaneous interventions [PCI]) is worse than that of patients not having diabetes [1]. Smaller vessel size, longer lesion length, greater plaque burden, negative vessel remodeling, and glycation-dependent activation pathways of smooth muscle cell after arterial injury are probably related to early restenosis of coronary stents and graft occlusion in this subset of patients [2]. The 2011 American Heart Association guidelines suggest that patients with diabetes and multivessel coronary artery disease may have a better outcome with CABG than with PCI [3]. The recommendation in favor of CABG was strongly supported by the recent Future Revascularization Evaluation in Patients With Diabetes Mellitus: Optimal Management of Multivessel Disease (FREEDOM) trial that found CABG to be superior to PCI with drug-eluting stents [4].

The long-term success of coronary artery bypass surgery is directly related to graft patency. Internal thoracic artery (ITA) when used to bypass the left anterior descending artery is associated with better long-term patency than saphenous veins, increased survival, and decreased recurrence of angina and reoperations [5]. Single ITA (SITA) graft has been recognized as an independent predictor of improved survival for diabetic patients [6]. Left-sided bilateral ITA (BITA) grafting is associated with improved survival, event-free survival, and freedom from repeat revascularization compared with SITA and saphenous vein graft (SVG) in the general population [7]. The application of BITA grafting technique in diabetic patients, however, is controversial, because its effect on long-term survival is questionable owing to the increased risk of sternal dehiscence and infection [8] caused by the extensive devascularization associated with harvesting BITA [9].

Accepted for publication June 13, 2016.

*Drs Pevni and Medalion contributed equally to this study.

Address correspondence to Dr Pevni, Department of Cardiothoracic Surgery, Sourasky Medical Center, 6 Weizman St, Tel Aviv 64239, Israel; email: pevnid@gmail.com.

Published by Elsevier

0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2016.06.044

Abbreviations and Acronyms

BITA	=	bilateral internal thoracic artery
CABG	=	coronary artery bypass graft surgery
CI	=	confidence interval
COPD	=	chronic obstructive pulmonary disease
CVA	=	cerebrovascular accident
EuroSCORE	=	European System for Cardiac Operative Risk Evaluation
IDDM	=	insulin-dependent diabetes mellitus
ITA	=	internal thoracic artery
MI	=	myocardial infarction
OR	=	odds ratio
PCI	=	percutaneous coronary intervention
PVD	=	peripheral vascular disease
SITA	=	single internal thoracic artery

The purpose of the present report is to compare the early and long-term outcome of BITA grafting with that of SITA with SVG, in patients with diabetes.

Material and Methods

This retrospective review of medical records and the use of a telephone questionnaire for obtaining follow-up information were approved by the Institutional Review Board. Between 1996 and 2010, 964 consecutive diabetic patients with multivessel CAD underwent primary left-sided (left anterior descending artery and circumflex system) BITA grafting. They were compared with 564 patients who underwent CABG with SITA and SVG in our institution during the same period. Follow-up information was 97% complete.

Surgical Techniques

Operations were performed using standard cardiopulmonary bypass or off-pump CABG. Myocardial preservation during cardiopulmonary bypass involved intermittent blood cardioplegia. The ITAs were harvested as skeletonized vessels. In most cases, BITA were used to graft the left coronary system. Two graft arrangements were implemented: in-situ BITA grafting and composite T grafting with a free right ITA attached end to side on the left ITA. The choice of configuration was determined by previously detailed technical considerations [10, 11]. There was a tendency not to choose BITA for patients with increased risk for sternal wound complications (eg, patients with chronic obstructive pulmonary disease [COPD] or repeat operations, and obese female patients) [10]. Our strategy was to use right gastroepiploic artery and radial artery as grafts to the right coronary artery branches only in the presence of a significant stenosis (ie, more than 80%) [10]. When the right coronary artery stenosis was less than 80%, we selected SVG as the conduit for revascularization. To decrease the risk of spasm of the arterial grafts, all patients were treated with a high-dose intravenous infusion of isosorbide dinitrate (Isoket; UCB Pharma Limited, Berkshire United Kingdom), 4 to 20 mg/h, during the first 48 postoperative hours.

Definition of Terms and Data Collection

Patient data were analyzed according to the European System for Cardiac Operative Risk Evaluation (EuroSCORE) [12] and American College of Cardiology/American Heart Association clinical data standards [13]. 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 a history of any cerebrovascular event (CVA) with or without permanent neurologic damage. Our definition of "emergency operation" was based on the EuroSCORE and includes patients operated on within 24 hours of cardiac catheterization, or patients with ongoing angina, acute evolving myocardial infarction (MI), pulmonary edema, or cardiogenic shock. A perioperative MI was defined by the appearance of new Q waves on the electrocardiogram associated with elevated levels of creatine phosphokinase–myocardial band fraction greater than 50 mU/mL. A CVA was defined as a new permanent neurologic deficit and computed tomographic evidence of cerebral infarction.

Statistical Analysis

Data are expressed as the mean ± standard deviation or as a proportion. The χ^2 test and two-sample Student's 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 ratio (OR) and 95% confidence interval (95% CI) were compiled. The postoperative survival of each group was expressed by the Kaplan-Meier method, and survival curves were compared by the log rank test. Cox proportional hazards regression analysis was used to identify whether treatment with BITA versus SITA was an independent predictor of survival. The Cox model was used to compare adjusted survival between the groups after controlling for differences between groups in preoperative and operative characteristics (Tables 1 and 2). The results of the Cox analysis were expressed as hazard ratio and 95% CI. The Kaplan-Meier method and the Cox model were also used to compare survival and adjusted-survival between BITA and SITA in the subset of diabetic patients with noninsulin-dependent diabetes.

The preoperative patient's characteristics that were used for the multivariable analyses were as follows: age, sex, insulin treatment, obesity (body mass index $\geq$30 kg/m^2), hyperlipidemia, PVD, cerebrovascular disease, neurologic dysfunction, emergency surgery, critical preoperative state, recent MI, acute MI, old MI, chronic renal failure, congestive heart failure, COPD, unstable angina, left main disease, preoperative PCI, number of diseased vessels, and left ventricular ejection fraction. Intraoperative variables used for the Cox and logistic regression analyses were as follows: off-pump CABG, number of vessels grafted, sequential grafting right