Long-term outcomes of coronary artery bypass grafting patients supported preoperatively with an intra-aortic balloon pump

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Objective: Most studies describing the outcome of coronary artery bypass grafting patients supported preoperatively with an intra-aortic balloon pump (IABP) have reported early results. The purpose of our study was to evaluate the early and long-term results.

Methods: Of 2658 isolated coronary artery bypass grafting procedures performed from 1996 to 2001, 215 were supported preoperatively with an IABP. The indications for IABP insertion were cardiogenic shock in 18 (8.4%), acute evolving myocardial infarction in 38 (17.7%), clinical instability in 84 (39.1%), and critical coronary lesions in 75 (34.9%).

Results: Operative mortality was 12.6%. The mortality of the cardiogenic shock patients was greater (22.2%; $P = .174$). Logistic regression analysis showed patient age (odds ratio, 1.057; 95% confidence interval, 1.010-1.108) and cardiopulmonary bypass (CPB) time (odds ratio, 1.020; 95% confidence interval, 1.008-1.031) were associated with increased operative mortality. An increased number of bypass grafts had a protective effect (odds ratio, 0.241; 95% confidence interval, 0.113-0.515). The actual early mortality was lower than the logistic EuroSCORE calculated mortality (12.6% vs 32.8%, $P < .0001$). The mean follow-up was 8 ± 4 years. The Kaplan-Meier 10-year survival was 49%. The Cox adjusted overall (early and late) survival and major adverse cardiac events-free survival of the different IABP subgroups was similar. Cox analyses showed peripheral vascular disease, off-pump coronary artery bypass surgery, age, CPB time, female gender, and fewer bypass grafts were associated with decreased survival.

Conclusions: In patients supported preoperatively with an IABP, better early and long-term results were strongly related to younger age, a shorter CPB time, and a greater number of bypass grafts. Avoiding the use of CPB (off pump) in these emergency cases is not recommended. (J Thorac Cardiovasc Surg 2014;148:1869-75)

Several clinical studies have demonstrated improved outcome with insertion of an intra-aortic balloon pump (IABP) before surgery.[1,2] However, other clinical studies have failed to detect a significant difference in outcomes with the use of a preoperative IABP.[3,4] The greater rates of IABP-related complications observed in the past have dissuaded some surgeons from routine preoperative use of IABP in high-risk patients.[4]

The introduction of new IABP guidewires and technological improvements in catheter size and software have reduced the occurrence of complications[5] and have expanded the indications for preoperative IABP use.[6]

Most studies describing the outcome of high-risk coronary patients who have undergone surgery with preoperative IABP support have reported early results. The purpose of our study was to evaluate the early and long-term ($\leq$15 years postoperatively) results.

METHODS

Of 2658 patients undergoing isolated coronary artery bypass grafting (CABG) at Tel Aviv Medical Center from 1996 to 2001, 215 (8.1%) were supported preoperatively with an IABP that was not removed before surgery. The preoperative and intraoperative patient data (Table 1) and the indication for IABP insertion were collected from the hospital medical records. The indications for IABP insertion were cardiogenic shock (subgroup 1) in 18 (8.4%), acute evolving myocardial infarction (MI) with critical coronary stenosis (subgroup 2) in 38 (17.7%), clinical instability (subgroup 3) in 84 (39.1%), and critical coronary lesions without evidence of MI (subgroup 4) in 75 (34.9%). The expected operative mortality was calculated using the logistic EuroSCORE.[7] Follow-up data were obtained after institutional review board approval using a telephone questionnaire and the Israeli National Registry database.

Surgical Techniques

The IABP was inserted in all patients preoperatively, in most, in the catheterization laboratory.

Surgery was performed with standard cardiopulmonary bypass (CPB) or off-pump coronary artery bypass (OPCAB). Myocardial preservation during CPB involved intermittent, antegrade, or antegrade plus retrograde

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Abbreviations and Acronyms

BITA = bilateral internal thoracic artery
CABG = coronary artery bypass grafting
CI = confidence interval
CPB = cardiopulmonary bypass
IABP = intra-aortic balloon pump
ITA = internal thoracic artery
MACE = major adverse cardiac events
MACCE = major adverse cardiac or cerebrovascular events
MI = myocardial infarction
OPCAB = off-pump coronary artery bypass
OR = odds ratio
PVD = peripheral vascular disease

blood cardioplegia (30°-32°C). Coronary stabilization during OPCAB was facilitated with CTS stabilizers (Guidant, Cupertino, Calif) or the Octopus system (Medtronic, Minneapolis, Minn). Internal thoracic arteries (ITAs) were mobilized from the chest wall as skeletonized vessels. During the study period, in all patients undergoing bilateral ITA (BITA) grafting, BITAs were used to graft the left coronary system (ie, the myocardial territory supplied by the left anterior descending and left circumflex arteries).[8]

The department's strategy was to use the right ITAs, right gastroepiploic arteries, and radial arteries as grafts to the right coronary artery branches only in the presence of significant stenosis (ie, >80%).[9,10] However, in most cases, a saphenous vein graft was the preferred conduit for right coronary artery revascularization. The surgical variables are summarized in Table 2.

To decrease the risk of spasm of the arterial grafts, we treated all our patients with a high-dose intravenous infusion of isosorbide dinitrate (Isoket, See Agis, Monheim, Germany) during the first 48 hours postoperatively. Calcium channel blockers (diltiazem 90 to 180 mg/d orally) were given to patients operated on using the right gastroepiploic artery or radial artery from the second postoperative day for ≥3 months.[8]

Definition of Terms and Data Collection

The patient data were analyzed according to the American College of Cardiology/American Heart Association clinical data standards.[11]

A perioperative MI was defined by the appearance of new Q waves on the electrocardiogram associated with elevated levels of creatine phosphokinase-MB fraction >50 mU/mL. A cerebrovascular accident was defined as a new permanent neurologic deficit and computed tomography evidence of cerebral infarction. Chronic renal failure was diagnosed if the creatinine level was >1.8 mg/dL. Our definition of an "emergency operation" was determined using the Society of Thoracic Surgeons guidelines[12] and included patients operated on within 24 hours of cardiac catheterization, with ongoing angina, failed percutaneous transluminal coronary angioplasty, acute evolving MI, pulmonary edema, and cardiogenic shock. For patients who needed emergency surgery and were not stabilized after intra-aortic balloon counterpulsation, we usually used 1 ITA combined with saphenous vein grafts. Deep sternal infection was defined as the sum of deep infection and late dehiscence requiring sternectomy. An IABP-related vascular complication was defined as an acute perfusion compromise to a limb or an organ distal to the balloon position. An early unfavorable event was defined as the occurrence in the perioperative period of either 1 of the following: acute MI, acute cerebral infarct, deep sternal infection, IABP-related vascular complications, need for revision, or death.

Major adverse cardiac events (MACE) were defined as the occurrence of cardiac-related mortality, nonfatal MI, or the need for repeat coronary revascularization. Major adverse cardiac or cerebrovascular events (MACCE) were defined as either MACE or cerebral infarct. Complete revascularization was defined as revascularization of all coronary systems with vessel stenosis >70%.

Statistical Analysis

Data are expressed as the mean ± standard deviation or as a proportion. The chi-square test and 2-sample t test was used to compare discrete and continuous variables, respectively. Multivariate logistic regression analysis was used to predict early mortality and early unfavorable events using various risk factors. The odds ratios (ORs) and 95% confidence intervals (CIs) are presented. The Cox proportional hazards model was used to evaluate the influence of perioperative and operative variables on overall (early plus late) mortality and morbidity (MACE, MACCE, and angina recurrence). We used the stepwise conditional forward selection method in all multivariate analyses; however, the IABP subgroups were forced into all models. The results of the Cox analysis are expressed as hazard ratios and 95% CIs. Postoperative survival is expressed using the Kaplan-Meier method, and the survival curves were compared using the log-rank test. The Cox model was used for coronary risk-adjusted curves. All analyses were performed with Statistical Package for Social Sciences, version 18, software (SPSS, Inc, Chicago, Ill).

RESULTS

The patients' preoperative and operative characteristics are listed in Tables 1 and 2. The mean number of grafts per patient was 2.67. Of the patients, 53 (24.6%) underwent surgery without CPB (OPCAB). The average CPB time for patients treated with CPB was 94.5 ± 39 minutes, and the mean aortic crossclamp time was 72.0 ± 25 minutes. Operative mortality (30 days postoperatively) in the cohort of 215 consecutive IABP-supported patients was 12.6%. The early mortality of the patients with cardiogenic shock was 22.2% (4 of 18; $P = .174$ compared with the other subgroups of IABP insertion indications). Operative mortality for the female patients was 19.7% (12 of 61; $P = .043$) and for the patients with acute evolving MI was 17.1% (18 of 105; $P = .037$; Table 3).

Multivariate logistic regression analysis revealed that operative mortality was related to CPB time ($P = .001$; OR, 1.020; 95% CI, 1.008-1.031) and patient age ($P = .018$; OR, 1.057; 95% CI, 1.010-1.108). A CPB time of 70 minutes was a good threshold at which to best separate patients with good and poor outcomes. The mortality of patients with a CPB time of ≤70 minutes was 6.5% versus 14% and 17% for a longer CPB time and OPCAB, respectively ($P < .001$).

The use of BITAs was associated with decreased early mortality, as expected for the BITA patients (5.8% vs 17.1% for non-BITA patients; $P = .011$). However, BITA did not emerge as a significant predictor on multivariate analysis. An increased number of bypass grafts had a protective effect (OR, 0.241; 95% CI, 0.113-0.515; $P < .001$).

The mean additive and logistic EuroSCORE for the entire cohort was 12 ± 3 and 32 ± 2, respectively. The actual early postoperative mortality observed in each of the IABP