Left Ventricular End-Diastolic Pressure Predicts Survival in Coronary Artery Bypass Graft Surgery Patients

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Background. **There is a known association between a depressed left ventricular ejection fraction (LVEF < 0.35) and increased mortality in patients undergoing coronary artery bypass graft (CABG) operations. Recent studies show that elevated preoperative LV end-diastolic pressure (LVEDP) is an independent predictor of operative death for patients undergoing CABG. Therefore, the purpose of this study was to define the long-term predictive value of elevated LVEDP in CABG and its relationship to LVEF.**

Methods. **Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH), a clinical data collection initiative capturing all patients undergoing isolated CABG in Alberta, Canada, was used to identify 6,735 consecutive patients who had LVEDP and LVEF data recorded by catheterization undergoing isolated CABG between 1996 and 2011. Patients were divided into four groups based on LVEF and LVEDP: group 1 (LVEF ≥ 0.35, LVEDP < 18 mm Hg), group 2 (LVEF < 0.35, LVEDP < 18 mm Hg), group 3 (LVEF ≥ 0.35, LVEDP ≥ 18 mm Hg), and group 4 (LVEF < 0.35, LVEDP ≥ 18 mm Hg).**

Results. **Patients with an LVEF > 0.35 had improved long-term survival compared with patients with depressed LVEF (LVEF < 0.35, $p < 0.001$). In patients with a depressed LVEF, an elevated LVEDP was associated with decreased long-term survival (group 2 vs 4, $p < 0.001$). Other significant independent predictors for death were age, chronic obstructive pulmonary disease, peripheral vascular disease, dialysis dependence, and congestive heart failure ($p < 0.001$). Isolated elevated LVEDP was not an independent risk factor for long-term mortality.**

Conclusions. **In patients with a depressed LVEF, an elevated LVEDP is associated with poor long-term survival. These data support the added value of long-term prognostic value of LVEDP in patients with depressed LVEF undergoing CABG.**

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Risk stratification is an important preoperative assessment in patients undergoing coronary artery bypass graft (CABG) operations [1–6]. Risk factors for CABG have been well established and validated by several investigators, leading to the adoption of scoring risk models such as the European System for Cardiac Operative Risk Evaluation (EuroSCORE) [7] and the bedside Bernstein-Parsonnet score [5, 8]. Outcomes of patients undergoing isolated CABG with depressed left ventricular ejection fraction (LVEF) have improved as a result of advances in surgical techniques, myocardial protection, and improved long-term medical management after CABG. However, a depressed LVEF continues to be strongly associated with increased mortality in patients undergoing isolated CABG surgery [9, 10].

The importance of preoperative LV end-diastolic pressure (LVEDP) as an independent predictor of death in isolated CABG is uncertain. Elevated LVEDP has been associated with declining survival in cardiac surgery, although in most studies, elevated LVEDP is not an independent risk factor for death [1, 3, 4, 7]. Elevated LVEDP may represent multifactorial cardiac dysfunction, including systolic, diastolic, or mixed LV dysfunction [11].

Because quantitative echocardiographic evaluation of diastolic dysfunction is often not performed on all patients undergoing CABG, we accept elevated LVEDP as a surrogate for cardiac compromise with mixed etiologies. LVEDP is accessible for most patients undergoing elective or urgent CABG where a left ventricular angiogram is performed routinely to quantify LVEDP. In the present study, we aimed to examine the long-term predictive value of elevated LVEDP in patients undergoing isolated CABG and the relationship between LVEDP and LVEF.

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Abbreviations and acronyms

BMI = body mass index
CABG = coronary artery bypass grafting
CI = confidence interval
COPD = chronic obstructive pulmonary disease
CVD = cerebrovascular disease
DM = diabetes mellitus
EF = ejection fraction
GI = gastrointestinal
HR = hazard ratio
LVEDP = left ventricular end-diastolic pressure
LVEF = left ventricular ejection fraction
MI = myocardial infarction
PCI = percutaneous coronary intervention
PVD = peripheral vascular disease
NSTEMI = non-ST elevation myocardial infarction
STEMI = ST-elevation myocardial infarction

Patients and Methods

This study was approved by the University of Alberta Health Research Ethics Board–Biomedical Panel as acceptable within the limitations of patient outcomes research. Individual patient consent was waived because no individual patients were identified in the study.

Data Source

Data were collected from the Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease (APPROACH) database. This database is a prospective data collection initiative that gathers real-time data from all patients in all hospitals that provide cardiac catheterization and coronary revascularization in Alberta, Canada, beginning at the patient's referral for cardiac catheterization. Data are entered into the APPROACH registry along the patient's clinical trajectory. APPROACH contains demographic data and patient risk factors, comorbidities, other diagnoses, and procedural data. Adverse events data are also recorded in the APPROACH database and reviewed through various hospital-based morbidity and mortality rounds. Because the data in the APPROACH registry are used for clinical and administrative purposes, software checks have been put into place to ensure that there are limited missing data, particularly in the baseline characteristics of the patients in APPROACH [12]. Furthermore, for the purposes of research, we annually use a data replacement method that has been validated and ensures that the data are more than 95% complete [12].

From this base, patients are monitored longitudinally for the determination of short-term and long-term outcomes [13]. Vital statistics from the Alberta Bureau of Vital Statistics are merged quarterly with the APPROACH registry and were merged December 31, 2011, for this cohort. The purpose of this quarterly merge is to update the APPROACH registry and validate deaths that were entered independently (in-hospital or family identified) during the previous 4 months.

Study Cohort

In this study, cardiac catheterization or echocardiography, or both, were used to measure LVEF and LVEDP. Included were 6,735 consecutive patients who had isolated CABG in Alberta between January 1, 1996, and December 31, 2011. Patients undergoing concomitant cardiac surgical procedures and transplant recipients were excluded from this cohort. Patients were divided into four groups according to LVEF and LVEDP: group 1—LVEF 0.35 or more, LVEDP of less than 18 mm Hg; group 2—LVEF of less than 0.35, LVEDP of less than 18 mm Hg; group 3—LVEF of 0.35 or more, LVEDP of 18 mm Hg or more; group 4—LVEF of less than 0.35, LVEDP of 18 mm Hg or more.

Statistical Analysis

Preoperative categoric variables were compared among the four groups by χ^2 test for independence (degrees of freedom = 3), and continuous variables (age and body mass index) were compared by one-way analysis of variance with post hoc Bonferroni correction. Long-term survival after CABG was estimated using Kaplan-Meier actuarial log-rank statistics for the four groups. Multivariate regression using Cox proportional hazards modeling was used to determine independent risk factors for death for all patients analyzed in the cohort.

Results

Preoperative Characteristics

Isolated CABG was performed in 6,735 patients (18.2% female) with a mean age of 66 ± 11 years. The baseline characteristics and significance are summarized in Table 1. The four groups were similar in age; there were significantly fewer women with depressed LVEF (groups 2 and 4). Preoperative risk factors were similar among the four groups for history of cerebrovascular disease, dialysis-dependent renal failure, peripheral vascular disease, hypertension, dyslipidemia, malignancy, liver disease, prior percutaneous coronary intervention, and prior CABG. Patients with a depressed LVEF (groups 2 and 4) had a higher incidence of chronic obstructive pulmonary disease, congestive heart failure, history of smoking, and history of myocardial infarction ($p < 0.01$).

Coronary Angiography

The indications for angiography and anatomy of coronary disease are summarized in Table 2. Group 4 was significantly more likely to require angiography for the indication of ST-elevation myocardial infarction. As well, groups 2 and 4 were significantly more likely to have 2 or 3 significantly diseased coronary arteries than groups 1 and 3. However, the incidence of left main disease was similar among the four groups.