Heart, Lung and Circulation (2016) xx, 1–5
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2016.05.117

ORIGINAL ARTICLE

Relationship Between Diabetic Variables and Outcomes After Coronary Artery Bypass Grafting in Diabetic Patients

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Received 30 December 2015; accepted 19 May 2016; online published-ahead-of-print xxx

Background Nearly half of patients undergoing coronary artery bypass grafting (CABG) have diabetes. There is mixed data as to whether preoperative (haemoglobin A1c{HbA1c}) and/or perioperative diabetes control is associated with mortality and morbidity after CABG. We reviewed the characteristics and outcomes of diabetic patients undergoing CABG with a focus on HbA1c, perioperative glucose levels and diabetic treatment regimes.

Methods Diabetic patients undergoing CABG during July 2010 to June 2012 were studied (n=306). The last preoperative HbA1c levels, and perioperative glucose levels (mean and coefficient of variation (CV)) were retrospectively recorded, as well as the pre-existing and perioperative diabetes treatment regimens for analyses.

Results Mean HbA1c was 7.7+/-1.6%, and 11.1% (34), 56.2% (172), and 32.7% (100) of patients were managed preoperatively with diet only, oral diabetic medications and insulin respectively. For operative mortality which occurred in 2.0%, C-statistics (95% confidence interval) was only significant for HbA1c 0.855 (0.757-0.975) and glucose CV on the day of surgery 0.722 (0.567-0.877). HbA1c also detected postoperative renal failure c-statistic 0.617 (0.504-0.730), but not other complications or mortality during follow-up. In multivariate analysis, HbA1c was the only diabetes-related independent predictor of operative mortality hazards ratio 4.13 (1.04-16.4), and none of the diabetes-related variables predicted mortality during follow-up or other postoperative complications.

Conclusion Preoperative HbA1c was the only diabetic variable to independently predict after operative mortality after CABG, suggesting medium-term preoperative diabetes control being more important and prognostic of operative outcomes than perioperative diabetes control.

Keywords Diabetes mellitus • Coronary artery bypass grafting • Cardiac surgery

Introduction

Diabetes mellitus has become a global problem, affecting 360 million people in 2011, estimated to rise to 552 million by 2030, with over 95% having type 2 diabetes [1]. It is a well-established risk factor for coronary artery disease; between one quarter and half of patients undergoing coronary artery bypass grafting (CABG) have diabetes [2]. Coronary artery bypass grafting was found in most [3,4] but not all [5,6] randomised trials to be superior to percutaneous coronary intervention for multivessel coronary artery disease, particularly those with moderate or high Syntax score >22, and is recommended by guidelines in this context [7].

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Please cite this article in press as: Wang TKM, et al. Relationship Between Diabetic Variables and Outcomes After Coronary Artery Bypass Grafting in Diabetic Patients. Heart, Lung and Circulation (2016), http://dx.doi.org/10.1016/j.hlc.2016.05.117

Despite this, diabetes is also a predictor of higher mortality and morbidity after cardiac surgery [8,9]. There is therefore significant interest in identifying predictors of adverse events as well as strategies to optimise outcomes in this subgroup. Identifying the relative importance of perioperative glucose levels and haemoglobin A1c (HbA1c) for CABG outcomes can direct future treatment efforts towards improving either perioperative or medium-term glucose control. We reviewed the characteristics and outcomes of diabetic patients undergoing CABG.

Materials and Methods

Ethics approval was obtained prior to the commencement of the study. All patients undergoing isolated CABG without concurrent valve surgery during July 2010 to June 2012 at Auckland City Hospital with a verified history of diabetes mellitus were included. Mode of treatment (lifestyle only, oral medications or insulin) and last haemoglobin A1c (HbA1c in %) preoperatively but within three months of operation were recorded. Mean and coefficient of variation (mean/standard deviation) glucose levels (mmol/L) on the day of surgery, and on the day up till three days postoperatively were retrospectively obtained and calculated — individual glucose measurements were taken as only required clinically.

Other clinical pre and postoperative variables were defined in accordance with the Society of Thoracic Surgeon's (STS) database; and EuroSCOREs and STS Scores retrospectively calculated[8,9]. Angina and dyspnoea on presentation were graded using the Canadian Cardiovascular Society Classification (CCS) and New York Heart Association Class (NYHA) respectively. Valvular disease of at least moderate severity was recorded. Renal function was calculated using the last preoperative creatinine and the Modification of Diet and Renal Disease (MDRD) formula to give estimated glomerular filtration rate (eGFR) [10].

Mortality data up till 31 December 2013 were checked against New Zealand's national registry, and operative mortality (in-hospital or within 30 days) and mortality during follow-up were recorded. Society of Thoracic Surgeon's definitions for five postoperative complications (stroke, renal failure, ventilation >24 hours, deep sternal wound infection and return to theatre) and their composite [8], as well as length of hospital stay postoperatively were also collected.

Quantitative variables are presented as mean+/-standard deviation and categorical variables as percentage (frequency). C-statistics (area under the receiver-operative characteristics (ROC) curve) with 95% confidence interval (95% CI) was used to assess discrimination of diabetic variables for outcomes. Mann-Whitney U test and Fisher's exact test were used for univariate analyses for quantitative and categorical variables respectively. Variables with P<0.10 in the aforementioned analyses were incorporated into multivariate analyses, using logistic regression to calculate odds ratios (OR) or Cox proportional hazards regression used to calculate hazards ratios (HR). Analyses were performed using SPSS (Version 17.0, SPSS Inc., Chicago, IL, USA) and Prism (Version 5, GraphPad Software, San Diego, CA, USA). All tests were two-tailed and significance level set at 5%.

Results

A total of 306 patients, all with type 2 diabetes mellitus, were studied and followed-up for 2.3+/-0.6 years. Table 1 lists the baseline characteristics, and diabetic variables are found in Table 2. Mean HbA1c was 7.7+/-1.6% and mean and coefficient of variation of glucose on day of surgery were 7.9+/-2.1 mmol/L and 0.29+/-0.10.

Operative variables and postoperative outcomes are shown in Table 3. Operative mortality was 2.0% (6), and one-year survival of 95.7%. Composite morbidity was 21.9% (67), mainly due to prolonged ventilation >24 hours 15.0% (46), while postoperative stroke occurred in 0.7% (2).

Receiver-operative analyses results are listed in Table 4. Amongst diabetic variables, HbA1c, glucose coefficient of variation day of surgery and insulin use all could detect operative mortality, with HbA1c having the numerically highest area under curve. None of the diabetic variables were able to detect mortality during follow-up or composite morbidity.

Table 5 shows the multivariate analysis results. HbA1c was the only independent predictor of operative mortality, c-statistic 4.13, 95% confidence interval 1.04-16.1, P=0.44. Again, none of the diabetic variables were independent predictors of mortality during follow-up or composite morbidity, while estimated glomerular filtration rate predicted all three outcomes.

Discussion

Our study had several important findings. Rates of mortality and morbidity for our contemporary cohort of diabetic patients undergoing CABG were low. HbA1c, glucose coefficient of variation on day of surgery and insulin treatment were all associated with operative mortality, however only HbA1c independently predicted operative mortality. Diabetic variables did not independently predict mortality during follow-up or composite postoperative complications.

Although CABG is recommended as the preferred revascularisation modality of choice for multivessel disease in diabetics, caution is needed due to the higher risk of adverse outcomes in these patients [3,4,7]. In the EuroSCORE II risk model derived from their database, diabetics on insulin gave an odds ratio of 1.43 times higher risk of operative mortality [9]. In the STS database of isolated CABG, diabetics not on insulin had hazards ratio of 1.01, but if on insulin this increased to 1.30[8]. We also found insulin use to be a prognostic factor, and this is plausible because insulin use is generally in those with more advanced diabetes, poor control and possibly more complications of diabetes.

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