The Role of Preoperative Chronic Obstructive Pulmonary Disease to Predict Morbidity After Coronary Artery Bypass Surgery

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ABSTRACT

Prevalence of chronic obstructive pulmonary disease (COPD) among patients who are candidates for cardiac surgeries has a wide spectrum. Therefore, assessment of the prognostic value of preoperative COPD in different population is necessary. The present study assessed the role of different severities of COPD for prediction of morbidity in patients undergoing coronary artery bypass grafting (CABG). Five hundred and seventy consecutive patients underwent pure CABG were studied. Patients were divided into three groups depending on the spirometry as control (FEV1 80% or more, FEV1/ FVC> 0.7), mild to moderate COPD (FEV1 50% or more and FEV1/FVC 0.7 or less) and severe COPD (FEV1 less than 50% and FEV1/FVC 0.7 or less). Preoperative pulmonary function indices were assessed as predictors and postoperative morbidity was used as surgical outcome. Studied groups were similar with regard to coronary artery disease risk factors, except for hypertension and recent myocardial infarction that were more frequent in patients with severe COPD. Mean of body mass index in the group with severe COPD was significantly lower than the control group, however this parameter was comparable in control group and the group with mild to moderate COPD. Multivariate logistic regression analysis showed that preoperative FVC measure predicted post-CABG morbidity with the presence of confounders (OR: 0.989, 95% CI: 0.979 – 1.000, p=0.046). Among preoperative pulmonary function indices, FVC can effectively predict in-hospital morbidity after CABG.

Key words: Chronic Obstructive Pulmonary Disease, Coronary Artery Bypass Grafting, Spirometry.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a devastating disorder that is currently one of the main leading causes of mortality and morbidity whole of the world[1]. Epidemiological investigations reported the prevalence of COPD ranging 9%- 10% that was estimated based on physiologically definition of COPD and spirometry testing[2]. However, this prevalence among patients with coronary artery disease (CAD) especially those who are candidates for cardiac surgeries has a wide spectrum from 5.7% [3] to more than 25 % (In 4-6). Some recent studies, COPD had a pivotal role to predict adverse outcome after coronary artery bypass surgery (CABG). This identified risk factor was a main predictor for early and late outcome of CABG and also could effectively predict long-term postoperative complications and survival of these patients[5-7]. This appropriate predictive power has been found in different age groups[6]. Therefore, it seems that the selective use of screening preoperative pulmonary function testing should be routine in these patients[8]. However, it seems that the predictive role of COPD in patients undergoing CABG is potentially dependant on its defined so that the frequency of postoperative poor outcome after this surgery has been similar in most patients with mild-to-moderate COPD to those without COPD[9]. Furthermore, this similarity can be dependent on the difficulty of assigning a precise definition for COPD and its severity. In addition, according to reported wide range prevalence of COPD in CAD patients, assessment of the prognostic value of preoperative COPD in different population is necessary. The main goal of the present study was to assess the role of different severities of COPD for prediction of morbidity and prolonged length of stay in hospital and ICU stay in patients undergoing CABG.

Methods

Between May and September 2006, 570 consecutive patients underwent pure CABG. Among these patients, 319 patients had COPD on the basis of preoperative pulmonary function testing results which was defined as requires therapy for the treatment of chronic pulmonary compromise and had a forced expiratory volume in 1 s [FEV1] less than 80% or FEV1/forced vital capacity [FVC] less than or equal to 0.7 of predicted value[10]. Patients were divided into three groups depending on the spirometry: controls (FEV1 80% or more, FEV1/FVC> 0.7), mild to moderate COPD (FEV1 50% or more and FEV1/FVC 0.7 or less) and severe COPD (FEV1 less than 50% and FEV1/FVC 0.7 or less[10]. According to this definition, 58 patients had mild to moderate COPD and 261 patients suffered from severe COPD. This study excluded patients who underwent repeat CABG and patients who had undergone other cardiac or non-cardiac procedures.

The following variables were also complete on each patient at the admission day: demographic characteristics, history of CAD risk factors and cardiac status. Also, early outcome after CABG was assessed included: mortality (defined as death within 30 days of the CABG operation), morbidity (defined as the existence of at least one of these postoperative complications: wound infection, arrhythmias, brain stroke, and new respiratory failure), prolonged total length of stay in hospital (more than 14 days) and prolonged ICU stay (more than 48 hours).

Results were expressed as mean±SD for quantitative variables and percentages for categorical variables. Categorical variables between the groups were compared using ÷2 square test and continuous variables were compared by using one-way analysis of variance (ANOVA) test. The Tukey-Kramer test was used for post-hoc analysis when differences between the groups were significant according to simple ANOVA. Predictors exhibiting a statistically significant relationship with morbidity in the univariate analysis (P value equal or less than 0.1) were taken for a multivariate logistic regression analysis to investigate their independence. Odds ratios (OR) and 95% confidence intervals (CI) for OR were calculated. Model calibration was estimated using the Hosmer-Lemeshow (HL) goodness-of-fit statistic (higher P values imply that the model fits the observed data better). P values of 0.05 or less were considered statistically significant. All the statistical analyses were performed using SPSS version 15.0 for windows (SPSS Inc., Chicago, IL, USA).

RESULTS

Demographic characteristics and clinical data of patients with and without COPD are summarized in Table 1. The mean age and sex ratio were comparable in all groups. Mean of body mass index in the group with severe COPD was significantly lower than the control group (p=0.022), however this parameter was comparable in control group and the group with mild to moderate COPD (p=0.894). Studied groups were similar with regard to some general risk factors for CAD, except for hypertension and recent myocardial infarction that were more frequent in patients with more severe COPD. Also, ejection fraction was higher in control than severe COPD group (p=0.014), whereas the difference in ejection fraction between the control group and group with mild to moderate COPD was not statistically significant (p=0.648).

This study found no significant differences in parameters of postoperative morbidity between the patients without COPD and other patients with the different severity of COPD (Table 2), however, assessment the association between surgical

Table 1: Baseline characteristics and clinical data of studied patients

Characteristics	Total (n=570)	Mild-moderate COPD(n=58)	Severe COPD (n=261)	Control group (n=251)	p-value
Male gender	429 (75.3)	40 (69.0)	190 (72.8)	199 (79.3)	0.118
Age (year)	59.0±9.0	57.8±8.3	58.5±8.9	59.9±9.2	0.115
Body mass index (kg/m^2)	27.4±4.1	27.6±3.9	26.9±4.2	27.8±3.9	0.028
Family history of CAD	270 (47.4)	31 (53.4)	125 (47.9)	114 (45.4)	0.530
Cigarette smoking	206 (36.1)	19 (32.8)	106 (40.6)	81 (32.3)	0.124
Diabetes mellitus	233 (40.9)	22 (37.9)	116 (44.4)	95 (37.8)	0.282
Opium addiction	83 (14.6)	5 (8.6)	45 (17.2)	33 (13.1)	0.169
Hyperlipidemia	400 (70.2)	46 (79.3)	180 (69.0)	174 (69.3)	0.275
Hypertension	282 (49.5)	30 (51.7)	143 (54.8)	109 (43.4)	0.034
Peripheral vascular disease	158 (27.7)	13 (22.4)	82 (31.4)	63 (25.1)	0.178
Cerebrovascular disease	22 (3.9)	1 (1.7)	12 (4.6)	9 (3.6)	0.564
Recent myocardial infarction	287 (50.6)	31 (54.4)	148 (56.9)	108 (43.2)	0.007
Ejection fraction	48.5±10.4	48.5±10.3	47.3±10.4	49.8±10.2	0.019
Function class:					
I	201 (35.3)	23 (39.7)	79 (30.3)	99 (39.4)	
II	286 (50.2)	30 (51.7)	132 (50.6)	124 (49.4)	0.031
III	83 (14.5)	5 (8.6)	50 (19.2)	28 (11.2)	
Number of coronary involvement					
One	21 (3.7)	2 (3.4)	9 (3.4)	10 (4.0)	
Two	108 (18.9)	17 (29.3)	44 (16.9)	47 (18.7)	0.292
Three	441 (77.4)	39 (67.2)	20.8 (79.7)	194 (77.3)	

Data are presented as mean±SD or number (percentages)

Table 2: Early outcome after coronary artery bypass surgery in studied patients

Characteristics	Total (n=570)	Mild-moderate COPD(n=58)	Severe COPD (n=261)	Control group (n=251)	p-value
Wound infection	3 (0.5)	0 (0.0)	1 (0.4)	2 (0.8)	0.684
Arrhythmias	224 (39.3)	21 (36.2)	111 (42.5)	92 (36.7)	0.348
Respiratory failure	104 (18.2)	15 (25.9)	52 (19.9)	37 (14.7)	0.090
Brain stroke	4 (0.7)	0 (0.0)	2 (0.8)	2 (0.8)	0.795
Myocardial infarction	4 (0.7)	1 (1.7)	2 (0.8)	1 (0.4)	0.544
Morbidity	271 (47.5)	26 (44.8)	132 (50.6)	113 (45.0)	0.412
Prolonged length of stay in hospital (>14 days)	292 (51.2)	27 (46.6)	136 (52.1)	129 (51.4)	0.744
Prolonged ICU stay (>48 hours)	190 (33.3)	20 (34.5)	90 (34.5)	80 (31.9)	0.806

Data are presented as mean±SD or number (percentages)

complications and pulmonary function indices showed an adverse relationship between postoperative morbidity and FVC (Table 3). Multivariate logistic regression analysis (Table 4) also showed that preoperative FVC measure could effectively predict post-CABG morbidity with the presence of confounders (OR: 0.989, 95% CI: 0.979 – 1.000, p=0.046).

DISCUSSION

The present study had two main findings. Firstly, we could indicated that some CAD risk factors such as hypertension and recent myocardial infarction were more prevalent in patients with severe COPD than the control group, however body mass index was lower in the patients with severe COPD than others. Association between body mass index and the presence of severe COPD has been found in some COPD phenotypes. BMI can be significantly lower in the emphysema dominant phenotype than in the airway dominant phenotype and therefore, BMI measurement as a risk factor for CAD may be different in these phenotypes[11]. However, it has been also shown that after controlling for confounding factors such as cigarette smoking, age, abdominal obesity and educational status, men with low BMI are at increased risk for getting COPD and the risk of COPD developing in patients with low BMI was 2.76 times of other patients[12]. Even, pathological changes following reduction of BMI was also demonstrated so that mitochondrial respiratory dysfunction was impaired in low BMI group than other patients groups[13]. Furthermore, systemic hypertension is frequently encountered in COPD patients[14]. It has been suggested that COPD besides other risk factors such as hypertension can lead to high CAD-related mortality and longer hospitalization. Therefore, monitoring and control of these risk factors with particular care in patients with severe COPD are strongly recommended.

We could also show a significant association between postoperative morbidity and FVC so that the morbidity rate was higher in patients with lower preoperative FVC. This relationship was also confirmed in the presence of some important patients' indices such as age, IABP insertion, inotrope use, pacemaker insertion and number of

Table 3: Pulmonary function indices in groups with and without early complications

Outcome	FEV1	FVC	FEV1/FVC
Morbidity (+)	74.2 (%)	80.2 (%)	0.94
Morbidity (-)	76.0 (%)	83.6 (%)	0.92
p-value	0.263	0.012	0.280
LOS>14 days	74.9 (%)	81.8 (%)	0.93
LOS≤14 days	75.3 (%)	82.2 (%)	0.93
p-value	0.836	0.743	0.915
ICU stay> 48 hours	75.3 (%)	82.0 (%)	0.93
ICU stay ≤ 48 hours	75.0 (%)	82.0 (%)	0.92
p-value	0.902	0.983	0.653

Table 4: Mutivariate analysis of the predictive power of forced vital capacity for prediction of postoperative morbidity

Variable	Univariate p-value	Multivariate p-vakue	Odds Ratio	95% Confidence Interval
Forced vital capacity	0.012	0.046	0.989	0.979 – 1.000
Advanced age	<0.001	0.002	1.032	1.011 – 1.053
Hyperlipidemia	0.040	0.151	1.323	0.903 – 1.939
Peripheral vascular disease	0.016	0.013	0.607	0.410 – 0.899
Serum creatinine	0.001	0.011	2.443	1.230 – 4.850
IABP insertion	0.050	0.140	0.359	0.092 – 1.402
Inotrope use	0.029	0.260	0.816	0.573 – 1.163
Pacemaker insertion	0.005	0.098	0.589	0.314 – 1.103
Number of grafts	0.046	0.006	1.266	1.078 – 1.564

Hosmer and Lemeshow test: χ^2 = 6.604, df = 8, p-value = 0.580

used grafts. Most of the similar studies could also show the role of impaired airway flow for predicting of postoperative early outcome[5,10,15,16], and also long-term survival[6]. However, relationship between pulmonary function parameters and post-CABG outcome was not observed in some other studies[17,18]. Some investigations showed that the index of FEV1 had main role to predict morbidity, prolonged LOS and ICU stay in these patients. Canver *et al*[4] showed that preoperative FEV1 was a significant predictor of 5-year survival in the young and aged individuals undergoing Also, Fuster *et al*[5] found that preoperative FEV1 less than 60% must be considered as a primary prognostic factor in patients undergoing CABG procedures. Besides, similar to our study, some others emphasized on the role of FVC as an important predictor for postoperative events. Durand *et al*[16] found that low FVC was associated with mortality, reintubation and prolonged ventilation after surgery. It seems that the predictive role of FVC following CABG is mainly related to the prediction of postoperative respiratory complications and arrhythmias. There is increasing evidence that COPD patients undergoing CABG surgery are at increased risk for postoperative respiratory complications and arrhythmias[17-20]. According to high respiratory complication rate and arrhythmia in our study, predictive power of FVC was more documented. It is well known that respiratory muscles dysfunction due to surgery can lead to a reduction in FVC. This may cause atelectasis in the basal lung segments which affects the gas exchange properties of the lung, pulmonary infections, which have significant morbidity and mortality in this patient population[21,22]. In severe cases, these consequences of impaired respiratory muscle function may also lead to respiratory failure and notable mortality and morbidity[23]. However, the relationship between preoperative low FVC and postoperative morbidity can be observed in patients with the history of severe COPD and in cases with mild to moderate pulmonary dysfunction, this association as shown in Michalopoulos *et al.,*[24] assessment may not be demonstrated.

In conclusion, among CAD risk factors, hypertension and recent myocardial infarction were more frequent in patients with severe COPD than the groups with normal pulmonary function test, however obesity was more observed in normal group. Frequencies of these risk profiles were comparable in control group and the group with mild to moderate COPD. Among pulmonary function indices, FVC could effectively predict in-hospital morbidity after CABG.

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