Research Article

The Impact of COPD on Early Results After Cardiac Surgery

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Abstract

Objective: Chronic obstructive pulmonary disease (COPD) is associated with significant morbidity and mortality after cardiopulmonary bypass (CPB). This study aimed to evaluate the impact of COPD on early post operative results.

Patients and methods: Between January 1994 and December 2015, 2416 adult's patients who underwent CPB are analyzed retrospectively. Among them 145 (6%) had a history of COPD. The relevant pre, intra and postoperative data were compared between COPD patients on non-COPD patients.

Results: Patients with COPD are older than those without COPD (p<0.001). Coronary artery disease is more prevalent in COPD group. Patients with COPD were more symptomatic. Also, preoperative comorbidities such as peripheral arterial disease, renal dysfunction and left ventricular dysfunction were more prevalent in COPD group. No significant difference was noted between the two groups with regard to in-hospital mortality (p=0.17). But COPD correlated with many negative outcomes such as: prolonged mechanical ventilation, prolonged intensive care unit stay, excessive bleeding, pneumonia, low out post syndrome, postoperative renal failure and acute myocardial infarction.

Conclusion: COPD did not increase in-hospital mortality after CPB, but it correlated with increased many postoperative complications.

Keywords: COPD; CPB; Cardiac Surgery

1. Introduction

Epidemiological investigations have reported that the prevalence of chronic obstructive pulmonary disease (COPD) among a general population range from 8 to 20%, on the basis of the physiological definition of COPD [1,2]. The EuroSCORE system includes chronic lung disease as an independent predictor of operative mortality [3]. Patients with mild COPD seem to have even a higher risk of dying from cardiovascular causes than respiratory insufficiency [4]. Postoperative complications such as respiratory failure that need re-intubation or prolonged mechanical ventilation assistance is common in this group of patients after cardiopulmonary bypass (CPB). It is known also that various comorbidities are associated with COPD [5]. Additionally, care provided in the intensive care unit (ICU) is costly and labor intensive [6,7].

In the present study, we retrospectively try to assess the negative impact of COPD in the prediction of morbi-mortality in patients who underwent open heart surgery.

2. Patients and methods

From January 1994 to December 2015, 2416 adult patients (>18 years) suffering from heart disease underwent surgery under CPB. Among them, 145 patients (6%) had a history of COPD.

According to the Gold COPD 2011 Guidelines, COPD was defined as a common, preventable and treatable disease, characterized by persistent airflow limitations, which are usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles and gases. Clinical diagnosis of COPD should be considered in a patient who has dyspnea, chronic cough, or spume production and/or a history of exposure to risk factor for the disease.

The study was approved by the local ethics committee. Due to its retrospective nature, patient's consent was not obtained. Preoperative, intraoperative and postoperative variables were collected and investigated. Demographic characteristics included: age, sex, body mass index (BMI), history of coronary artery disease (CAD) risk factors, cardiac status (NYHA functional class, Canadian classification of angina pectoris), comorbidities: renal dysfunction, prior cerebro-vascular accident (CVA), recent acute myocardial infarction (AMI), prior heart surgery, peripheral vascular disease (PVD), left ventricular ejection fraction (LVEF), type of surgery: valvular surgery, coronary artery bypass grafting (CABG), combined procedure, aortic rout surgery.

Intraoperative variables included the duration of CPB, aortic cross clamp (ACC) time, and the duration of the procedure. Postoperative data included: duration of mechanical ventilation (MV), ICU stay, postoperative hospital

stay, bleeding during the first 24 hours, the dependency to inotropes drugs, and the requirement of intra-aortic balloon pulse (IABP).

All patients were premedicated before operation. After routine monitoring was initiated, general anesthesia was induced and maintained depending our protocol. All procedures were performed through a median sternotomy. CPB was conducted with a membrane oxygenator, heparin was administrated repetitively to maintain an activated clotting time (ACT)>400 seconds. Non-pulsatile flow was maintained at 2.5 L/min/m² and the mean blood pressure was kept at 50-70 mmHg. Cardiac arrest was achieved by cold blood cardioplegia.

After completion of surgery, the patient was weaned from CPB. Stress ulcer prophylaxis was achieved in all patients by intravenous H2 receptor antagonists or proton pump inhibitor during the operation and ICU stay.

2.1 Definitions

The early postoperative complications are listed as:

-Mortality: defined as death within 30 days of open heart surgery.

-Morbidity: defined as the existence of at least one of the following adverse events:

- Low output syndrome (LOS), considered when postoperative excessive inotropic support (epinephrine or dobutamine) was used for more than 24 hours or IABP requirement.
- Acute myocardial infarction (AMI) diagnosed when the new Q ware occurs within 48 hours.
- Stroke: new permanent neurological event.
- Acute renal failure (RF): absolute increase >0.3mg/dl or relative increase >50% in the serum creatinine level compared to the preoperative bare line value.
- Pulmonary infections included pneumonia and bronchitis. Pneumonia was defined by radiological evidence of new infiltration, antibiotic usage in the presence of one of the three following criteria: purulent sputum, positive blood culture, or positive bronchial secretion culture.
- Postoperative ventilator dependency: defined as the time between cardiac procedure and extubation of more than 48 hours.

2.2 Statistical analysis

Statistical analysis was performed with SPSS 19.0. Continuous data were expressed as mean ± SD or median with interquartile range. Nominal data were presented as frequencies and percentages. Differences between groups were analyzed by t-student test or U-Mann-Whitney test for quantitative variables and chi-squared test or fisher's exact test for categorical variables. P value <0.05 was considered statistically significant.

3. Results

A total of 2416 adult patients who underwent CPB for various cardiac procedures were enrolled in this study. 145 of them had a history of COPD, accounting for 6%. These patients were compared with those without lung disease (n=2271). Demographic details of both groups are summarized in Table 1. Many significant differences were

observed between patients who had a history of COPD and those without COPD. Patients with COPD are older than patients without COPD (58.3 ± 10.3 years vs 48.5 ± 14 years, $p<0.001$). There was a more male gender in COPD group ($p<0.001$). Coronary artery disease risk factors were more prevalent among patients with COPD. Smoking was the most prevalent CAD risk factor (77.9%) followed by diabetes mellitus (33%), hyperlipidemia (27.5%) and hypertension (26.2%).

Variable	**COPD n= 145**	**Non COPD 2271**	*p* value
Age (years)	58.3 ± 10.3	48.5 ± 14	<0.001
Female n(%)	19 (13%)	889 (39.1%)	<0.001
BMI (kg/m²)	24.5 ± 4.2	24.8 ± 4.5	0.54
Smoking history n(%)	113 (77.9%)	727 (32%)	<0.001
Diabetes mellitus n(%)	48 (33%)	446 (19.6%)	<0.001
Hypertension n(%)	38 (26.2%)	439 (19.3%)	0.044
Hyperlipidemia n(%)	40 (27.5%)	319 (14%)	<0.001
Prior heart operation n(%)	11 (7.5%)	212 (9.3%)	0.48
NYHA functional class III-IV n(%)	19 (13%)	174 (7.6%)	0.019
Angina pectoris III-IVn(%)	34 (23.4%)	254 (11.2%)	<0.001
Peripheral vascular disease n(%)	30 (20.7%)	155 (6.8%)	<0.001
Cerebrovascular disease (%)	8 (5.5%)	94 (4.2%)	0.42
Renal dysfunction n(%)	15 (10.3%)	115 (5.06%)	0.006
Atrial fibrillation n(%)	15 (10.3%)	665 (29.2%)	<0.001
Gastric duodenal ulcer	13 (8.9%)	78 (3.4%)	0.001
Number of CVRF	2 [1-3]	1 [0-2]	<0.001
Low LVEF (<40%)	42 (28.9%)	260 (11.4%)	<0.001
Euroscore	4 [2-7]	2 [1-4]	<0.001
Coronary artery disease	86 (59.3%)	634 (27.9%)	<0.001
Valvular disease	51 (35%)	1484 (65.3%)	<0.001
CTI	0.54 ± 0.07	0.55 ± 0.06	0 .075

Table 1: Preoperative demographic characteristics of the patients

BMI: Body Mass Index; **CTI**: Cardiothoracic Index; **CVRF**: Cardiovascular Risk Factors; **MI**: Myocardial Infarction; **LVEF**: Left Ventricular Ejection Fraction

According to Canadian cardiovascular society angina class, patients with COPD were more symptomatic compared with non-COPD group (angina perctoris III-IV: 23.4% vs 11.2% $p<0.001$), and 13% of patients with COPD were in

advanced heart failure vs 7.6% in non-COPD group (p=0.019). With regard to preoperative associated comorbidities, peripheral vascular disease, renal dysfunction, gastro-duodenal ulcer were frequent among patients suffering from COPD, while the rate of cerebral-vascular disease and anemia were similar in both groups. In addition, patients with COPD had significantly higher rate of coronary artery disease (59.3%) while non-COPD group had more valvular heart disease (65.3%). Also, atrial fibrillation was more prevalent in non-COPD (29.2% vs 10.3%, p<0.001).

Left ventricular dysfunction was more frequent in COPD (28.9% vs 11.4% p<0.001). Overall mean EuroSCORE was higher in the COPD group than non-COPD group (4 [2-7] vs 2 [1-4] p<0.001). Intraoperative and postoperative data were presented in Table 2.

Variable	**COPD n= 145**	**Non COPD n= 2271**	***p* value**
No elective surgery n(%)	14 (9.6%)	102 (4.5%)	0.005
CPB time (min)	107 [85-140]	91 [70-120]	<0.001
Aortic cross clamp time (min)	64 [54-84]	60 [45-82]	0.19
Operative time (min)	225 [180-271]	198 [160-240]	<0.001
MV time (hours)	10 [6-19]	8 [5-17]	0.008
MV≥ 48 hours)	19 (13.3%)	152 (6.6%)	0.003
ICU stay (hours)	48 [44-72]	45 [24-48]	<0.001
Postoperative hospital stay (days)	11 [9-15]	11 [9-14]	0.28
Inotropic drugs n(%)	31 (21.3%)	283 (12,4%)	0.002
IABP n(%)	18 (12.4%)	107 (4.7%)	<0.001
LCOS n(%)	26 (17.9%)	209 (9.2)	0.001
Postoperative AMI n(%)	18 (12.4%)	89 (3.9%)	<0.001
Pneumonia	24 (16.5%)	153 (6.7%)	<0.001
Reoperation for bleeding n(%)	11 (7.5%)	77 (3.4%)	0.009
RBC transfusion	71 (48.9%)	770 (33.9%)	<0.001
Stroke	1 (0.6%)	27 (1.1%)	0.56
Postoperative RF n(%)	17 (11.7%)	153 (6.7%)	0.023
Excessive bleeding (> 1000ml/24h)	22 (15%)	172 (7.5)	0.001
30 day mortality	13 (8.9%)	139 (6.1 %)	0.17

Table 2: Operative and postoperative characteristics of the patients

CPB: Cardiopulmonary Bypass; **IABP**: Intra-Aortic Balloon Pump; **ICU**: Intensive Care Unit; **LCOS**: Low Cardiac Outpout Syndrome; **MV**: Mechanical Ventilation; **RBC**: Red Blood Cell; **RF**: Renal Failure

No-elective surgery was twice frequent in COPD compared with non-COPD group (p=0.005), CPB time and surgical procedure time were longer in COPD group (p=0.004 and p<0.001 respectively). Patients with lung disease experienced delayed extubation (p=0.003) and had longer ICU length of stay (p<0.001). But hospital length of stay was similar in both groups. The 30 day mortality rate was slightly high in patients with COPD compared with non-COPD, but it did not reach statistical significant (8.9% vs 6.1% p=0.17). However, when we looked at the postoperative complications, there was a statistically significant difference between the groups. Patients with COPD experienced more low cardiac output syndrome than those without COPD (p=0.001). The number of patients who needed pharmacological inotropic support was 31 (21.3%) in COPD group vs 283 (12.4%) in non-COPD group (p=0.002). Also, the requirement of IABP was frequent in COPD patients (p<0.001).

As demonstrated in Table 2, pneumonia was significantly higher in the COPD group (p<0.001). Similarly, those patients were also likely to develop postoperative renal insufficiency with or without requiring hemodialysis (p=0.023). Excessive bleeding and need for chest re-exploration and red blood cell (RBC) transfusion were frequent in patients with COPD.

4. Discussion

In this study, we found that COPD correlated with negative impact on immediate outcomes in patients undergoing CPB. Postoperative complications are more prevalent in patients with COPD who underwent cardiovascular surgery with CPB, contributing to long hospitalization periods, high mortality and morbidity. Our results reveal that patients with COPD account for 6% of all cardiovascular procedures performed in our center, this finding was in accordance with previous reposts: 5.7% in Medalion's study [8] and 7.17% in Miguel’s study [9].

Patients with COPD showed a higher risk profile, elderly patients with comorbidities. Coronary artery disease risk factors such as smoking, diabetes mellitus, hyperlipidemia and hypertension are more prevalent. Also, extra-cardiac medical problems such as peripheral vascular disease and renal dysfunction are more frequent in patients with lung disease.

Most of patients with COPD underwent CABG (59.3%) while 27.9% only in the control group. The association between COPD and CAD is well known [10]. This finding was in accordance with previous reports [11]. Smoking is highly prevalent among patients with COPD 77.9% vs 32% in non-COPD (p<0.001). It is well known that cigarette smoking plays a significant role in both coronary artery atherogenesis and COPD [12,13]. The left ventricular global function is affected in COPD patients, especially with progression of the disease.

In our study, patients with COPD had poor left ventricle (LV) function more than those without a history of COPD. El Wahsh et al. [14] found that Doppler tissue echocardiography is better tool in the assessment of left ventricular function. Najafi et al. [15] found that low ejection fraction was more prevalent in patients with COPD than in the control group.

In the other hand, we found that in-hospital mortality rate was slightly higher in patients with COPD than in non-COPD group, but it did not reach statistical significance (8.9% vs 6.1% p=0.17). Chung Han Ho et al. [16] reported a 7.23% in-hospital mortality rate in patients with COPD undergoing CABG surgery.

There is a conflicting impact of COPD on patient outcomes after CPB. A recent data base study reported that 30 day mortality rate after CABG surgery has greatly improved over the past decade [17].

Miguel et al. [9] has compared percutaneous coronary intervention (PCI) vs CABG in patients with and without COPD between 2001 and 2011, they found that in-hospital mortality rate among patients with COPD who underwent a CABG decreased significantly over the entire period. Similarly, in our study, we noted significantly the higher incidence rate of postoperative complications in patients with COPD than the no-COPD.

It is more evident that COPD patients undergoing CABG are at an increased risk of postoperative respiratory complications [18]. Adverse respiratory system events have traditionally been the leading cause of postoperative complications. Therefore, COPD has been established as an important risk factor for mortality in patients undergoing CABG [1]. It is well known that CPB induce systemic inflammatory response syndrome, which is correlated with duration of CPB. Atelectasis is one of the most important problems after CPB, especially in the early postoperative period.

Similar to previous study, we found that patients with COPD had a higher incidence of pneumonia than in the control group (16.5% vs 6.7% p<0,001). Mangas et al. [20] reported similar results. During CPB, both heart and lung are excluded from the circulation, whereas the myocardium is protected by cardioplegia, however no measures are taken to protect the lung. It is well known that this may causes atelectasis in the basal lung segments which compromises the gaze exchange, and predispose these patients to pulmonary infections. In a recent study, Kiessling et al [21] demonstrated a beneficial effect of selective pulmonary perfusion during CPB, on the inflammatory response and clinical outcome in patients with COPD. Patients undergoing cardiac surgery are generally able to resume spontaneous ventilation as soon as they have recovered from anesthesia. However, approximately 2.6 to 22.7% of them require prolonged mechanical ventilation [22]. In parallel with some studies [22,23] we found a relationship between history of COPD and increased risk of prolonged ventilation support. Damien et al [24] found that ventilator dependency following CPB was associated with long ICU stay. Our findings are in accordance of those studies, because we noted that patients with COPD had prolonged ICU stay, defined as greater than 48hours. However, multivariate logistic regression analysis retained LOS and chest re-exploration for bleeding as predictor's risk factors for prolonged mechanical ventilation.

In a systematic review published recently, Al Moshrafi et al [6] analyzed factors influencing length of stay in ICU after adult cardiac surgery, and noted that COPD was the main independent risk factor that impact negatively the duration of ICU.

4.1 Study limitation

The present study is limited by its retrospective design and small sample size. The relatively long time period of this study may carry along variables changes in diagnostic tool and medical management of COPD. Another limitation of this study was the lack of detailed respiratory function data, because it was not routinely measured before cardiac surgery in our center. Therefore, we cannot evaluate the severity of COPD that may affect postoperative outcome.

5. Conclusion

This study failed to show that COPD increased in hospital mortality after cardiac surgery, but those patients are inclined to develop postoperative complications.

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