Study of Impact of Mild to Moderate Symptomatic Chronic Obstructive Pulmonary Disease on Early Morbidity and Mortality Post Coronary Artery Bypass Grafting

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Abstract
Background: Due to common risk factors including smoking, patients with COPD often also suffer from coronary artery disease (CAD). Previous research has shown that patients with COPD who have CABG have a higher risk of mortality and complications. Between 8 to 20 percent of the population has chronic obstructive pulmonary disease (COPD), and moderate COPD is linked to greater cardiovascular mortality rates than respiratory insufficiency.
Aim: To find Better management of patients with mild to moderate symptomatic COPD and those without COPD undergoing (CABG) and to improve post-operative outcome.
Methods: This study was conducted at Cardiothoracic Surgery Department, Zagazig University Hospitals. The study included 48 patients who underwent coronary artery bypass grafting with mild to moderate symptomatic COPD and without Chronic obstructive pulmonary disease subdivided into two groups.
Results: All Lung volume measurements were significantly increased in COPD patients. PaO2, and PH were significantly decreased in COPD patients. PaCo2 was significantly increased in COPD patients. There was a significant increase in CPB time and Aortic Cross-Clamping in COPD patients. Mechanical ventilation time, ICU time and total time of hospital stay were significantly increased in COPD patients.
Conclusion: Our study highlights the impact of COPD on early morbidity and mortality post CABG. Patients with COPD who undergo CABG surgery experience a longer duration of mechanical ventilation, ICU stay, and total hospital stay, as well as a higher incidence of atelectasis, which may be attributed to the impaired lung function and reduced respiratory capacity observed in these patients.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), coronary artery bypass grafting (CABG).

Introduction

Patients with COPD often suffer from coronary artery disease (CAD) due to the fact that both COPD and CAD share smoking as a common risk factor. High rates of morbidity and mortality have been previously documented in patients with COPD who underwent coronary artery bypass grafting (CABG). **[1]**

According to epidemiological studies, when using a physiological definition of COPD, the prevalence of COPD in the general population is anywhere from 8 to 20 percent. **[2]**

Chronic lung illness is an independent predictor of operational mortality, according to the EuroSCORE system.[3]. Cardiovascular disease appears to be a greater killer of patients with moderate COPD than respiratory failure alone.**[4].**

After cardiopulmonary bypass, this population of patients frequently experiences postoperative problems, such as respiratory failure requiring re-intubation or prolonged mechanical ventilation assistance (CPB). **(5)** It's also well-established that COPD is linked to a number of other conditions. Care in an intensive care unit (ICU) is both expensive and time consuming. **[6,7]**

The prevalence of CABG in COPD patients has increased as a result of developments in surgical methods, anaesthetic, and postoperative care. The effects of COPD on postoperative mortality and complications varied between studies. Patients with mild to moderate COPD had mortality rates similar to those without COPD, but only those with severe COPD had a higher risk of death**.[8]**

Furthermore, studies have shown that the severity of airflow obstruction does not affect the death rate of patients receiving CABG, and that COPD is not an independent risk factor for greater mortality and morbidity rates. As a result, the current study compared the perioperative outcomes and death rates of CABG patients with and without COPD**.[9]**

We aimed at this work to find better management of patients with mild to moderate symptomatic COPD and those without COPD undergoing (CABG) and to improve post-operative outcome.

Subjects and Methods:

This Prospective cohort study was conducted in Cardiothoracic Surgery Department, Zagazig University Hospitals in 2022 on Patients who underwent coronary artery bypass grafting (CABG) with mild to moderate symptomatic chronic obstructive pulmonary disease (COPD) against patients who underwent CABG without COPD.

Inclusion criteria:

1) mild to moderate symptomatic COPD patients.
2) age group from (40y-60y).
3) non-COPD Patients undergoing CABG as a control group.

Exclusion criteria for surgical resection and re-anastomosis:

1) Studies including patients undergoing simultaneous valve surgery with CABG, aortic surgery or major surgical intervention.
2) other lung diseases as lung cancer, pneumonia, sarcoidosis, Asbestosis, tuberculosis, cystic fibrosis, idiopathic pulmonary fibrosis, pulmonary hypertension and bronchiectasis.
3) any patient with other comorbidities as obesity, diabetes, Renal Failure, stroke and chronic liver disease.
4) off pump patients.
5)severely symptomatic COPD patients.

Patients were divided into two groups, one for each of the two treatment modalities.

Steps of performance: All patients were considered to:

- Complete history taking:

- General and local chest examination: Vital signs, general look i.e. expanded barrel chest, wheezing during normal breathing with decreasing breath sound in patients with COPD.

Chest X-ray: All patients underwent a Chest X-ray in a supine position. Chest X-ray was acquired in the posteroanterior or anteroposterior projection.

CT chest was done if needed.

Laboratory studies:

- Pulmonary Function Test,
- ABG,
- CBC,
- Coagulation profile,
- inflammatory markers,
- KFT,
- LFT.

Pulmonary Function Tests were performed for all patients including
Spirometry:
FEV1, FVC, PEF were assessed.

Lung volume measurements:

- RV (Residual Volume), TLC (Total Lung Capacity), IC (Inspiratory Capacity) as well as ERV (Expiratory Reserve Volume) were measured.

Arterial blood gases were done.

Surgical maneuvers

Both study groups were then be followed up in the first 3months postoperative. Data were collected concerning:

Steps of CABG procedure:

Neuroleptics and analgesics were used to produce and maintain the state of general anaesthesia. The long saphenous vein was harvested at the same time as the left internal mammary artery (LIMA) was severed after a median sternotomy.

The heart was moved to a more advantageous position by using traction sutures on the pericardial edges. The left anterior descending coronary artery (LAD) was exposed by placing a damp sponge beneath the heart's laterodorsal side and luxating the heart somewhat medially and ventrally.

By shifting the right ventricle medially at its border, the distal right coronary artery was exposed in the atrioventricular groove. The patient was heparinized with 1 mg/kg, which is half the amount required for CPB.

Verapamil (5 mg) was injected intravenously just prior to the closure of the coronary artery to lower systemic blood pressure and heart rate. Proximal and distal to the chosen arteriotomy site, a 5-0 Prolene suture was placed around the coronary artery.

A small silicone tube was used to catch the suture, creating a dry operating environment. With a 7-0 Prolene running suture, a saphenous vein, LIMA, or other conduit was anastomosed to a 6-

mm longitudinal incision. There was a wide range in the time of coronary occlusion, from 11 minutes to 19 minutes.
After applying a tangential clamp to the ascending aorta, the proximal anastomoses were completed with a continuous suture of 6-0 Prolene. Heparin was inactivated with protamine sulphate once all anastomoses were closed.
Intraoperative: CPB time, Aortic cross-clamping, Reperfusion time.
Time spent with the patient on the heart-lung machine during the procedure is what was used to determine the cardiopulmonary bypass (CPB) duration.
Time for aortic cross-clamping was defined as the time needed for temporary occlusion of the aorta to interrupt blood flow from the heart, thereby enabling the performance of the bypass surgery on a quiescent heart.
The time it took for normal blood flow to be restored in the coronary arteries after the aortic cross-clamp was released at the end of the bypass procedure is known as the reperfusion time.
post-operative Primary outcome: Intubation time and ICU course.
Death, pneumothorax, pneumonia, respiratory failure, and cardiogenic shock were all reported for each patient in the first three months.

Statistical analysis
Statistical analysis was performed on all data using SPSS 26.0 for Windows (SPSS Inc., Chicago, IL, USA). Quantitative and qualitative information was presented in the same way. Minimum and maximum values, as well as the mean, median, and standard deviation, were used to characterise the quantitative data. All tests for statistical significance were two-tailed tests. If the P-value is less than 0.05, the difference is statistically significant; if it's greater than 0.05, it's not.

Results

Table (1): Demographic data and smoking habits.

	COPD (N = 24)	**Non-COPD (N = 24)**	**P. Value**
Age (Years)	50.67 ± 3.33	50.88 ± 2.97	0.8201
Sex			
• *Male*	18 (75%)	17 (70.83%)	
• *Female*	6 (25%)	7 (29.17%)	0.7451
BMI (Kg/m^2)	22.43 ± 0.62	22.44 ± 0.56	0.92298
Residence			
• *Urban*	10 (41.67%)	14 (58.33%)	
• *Rural*	14 (58.33%)	10 (41.67%)	0.2482
Smoking			
• *Smokers*	24 (100%)	11 (45.83%)	<0.0001*
• *Non-smoker*	0 (0%)	13 (54.17%)	

*P<0.05: statistically significant Data is represented as mean ± SD or number (Percentage) BMI: Basal metabolic index.
There was no significant difference between COPD and Non-COPD subjects regarding Demographic Data. However, smoking prevalence and duration was significantly increased in COPD patients.

Table (2): Pre-operative evaluations of included subjects.

	COPD (N = 24)	**Non-COPD (N = 24)**	**P. Value**
Pulmonary functions tests			
FEV1 (L)	2.34 ± 0.74	3.47 ± 0.02	<0.0001*
FVC (L)	3.24 ± 0.82	4 ± 0.03	0.00004*
FEV1/FVC	73.22 ± 16.58	86.88 ± 0.2	0.0002*
Arterial Blood Gases			
PaO2 (mmHg)	79.38 ± 7.82	93.29 ± 3.96	<0.0001*
PaCO2 (mmHg)	58.96 ± 5.79	41.58 ± 4.61	<0.0001*
pH	7.26 ± 0.04	7.4 ± 0.03	<0.0001*
Kidney function tests			
Creatinine (mg/dL)	0.94 ± 0.18	0.94 ± 0.22	0.99431
Albumin (g/dL)	4.46 ± 0.66	4.58 ± 0.69	0.54986
Liver function test			
ALT (U/L)	30.21 ± 13.24	27.46 ± 13.64	0.48205
CT findings			
Emphysema	6 (25%)	1 (4.17%)	0.121
Bronchitis	4 (16.67%)	2 (8.33%)	0.3827

All Pulmonary function data were significantly decreased in COPD patients and all Lung volume measurements were significantly increased in COPD patients. PaO2, and PH were significantly decreased in COPD patients. PaCo2 was significantly increased in COPD patients.
There was no significant difference between COPD and non-COPD patients regarding Kidney or Liver function tests.
There was non-significant difference between the 2 groups regarding CT findings.

Table (3): Intraoperative Evaluations of COPD and Non-COPD subjects.

	COPD (N = 24)	**Non-COPD (N = 24)**	**P. Value**
CPB time (min.)	112.33 ± 14.51	86.96 ± 20.25	0.00001*
Aortic Cross-Clamping (min.)	76.67 ± 10.82	53 ± 7.41	<0.0001*

There was significant increase in CPB time and Aortic Cross-Clamping in COPD patients.

Table (4): Post-operative evaluation at tome of discharge

	COPD (N = 24)	**Non-COPD (N = 24)**	**P. Value**
Mechanical ventilation (Hour)	10.92 ± 1.98	6.63 ± 1.61	<0.0001*
ICU time (Day)	5.25 ± 3.57	3.17 ± 3.34	0.04242*
Ward stay time (Day)	4.71 ± 2.14	4 ± 1.35	0.176468
Total time of hospital stay (Day)	11.21 ± 3.91	8.92 ± 2.45	0.018927*
Pulmonary function test			
FEV1 (L)	1.85 ± 0.6	2.93 ± 0.07	<0.0001*
FVC (L)	2.54 ± 0.66	3.34 ± 0.08	<0.0001*
FEV1/FVC	73.78 ± 17.54	87.76 ± 2.5	0.00035*
Post operative morbidity and mortality			
Pneumonia	5 (20.83)	1 (4.17%)	0.3827
Pneumothorax	4 (16.67%)	1 (4.17%)	0.1563
Wound infection	2 (8.33%)	1 (4.17%)	0.551
Atelectasis	12 (50%)	3 (12.5%)	0.0051*
Mortality	3 (12.5%)	2 (8.33%)	0. 2963

Mechanical ventilation time, ICU time and total time of hospital stay were significantly increased in COPD patients. Pulmonary function data was significantly better in non-COPD group at discharge and end of follow up.

There was no significant difference between COPD and non-COPD patients regarding Post operative morbidity and mortality except for atelectasis as it was significantly increased in COPD group.

Table (5): Pulmonary function data evaluations through time.

	COPD (N = 24)	**Non-COPD (N = 24)**	**P. Value**
Pre-Operative			
FEV1 (L)	2.34 ± 0.74	3.47 ± 0.02	<0.0001*
FVC (L)	3.24 ± 0.82	4 ± 0.03	0.00004*
FEV1/FVC	73.22 ± 16.58	86.88 ± 0.2	0.0002*
At time of discharge			
FEV1 (L)	1.85 ± 0.6	2.93 ± 0.07	<0.0001*
FVC (L)	2.54 ± 0.66	3.34 ± 0.08	<0.0001*
FEV1/FVC	73.78 ± 17.54	87.76 ± 2.5	0.00035*
After 3 months from operation			
FEV1 (L)	2.14 ± 0.67	3.26 ± 0.08	<0.0001*

FVC (L)	2.95 ± 0.73	3.79 ± 0.09	<0.0001*
FEV1/FVC	73.93 ± 17.46	86.1 ± 2.46	0.00147*

In Non-COPD group Pulmonary function data was significantly better (P<0.05) through time of the study (Pre-operative, at time of discharge and after 3 months from operation).

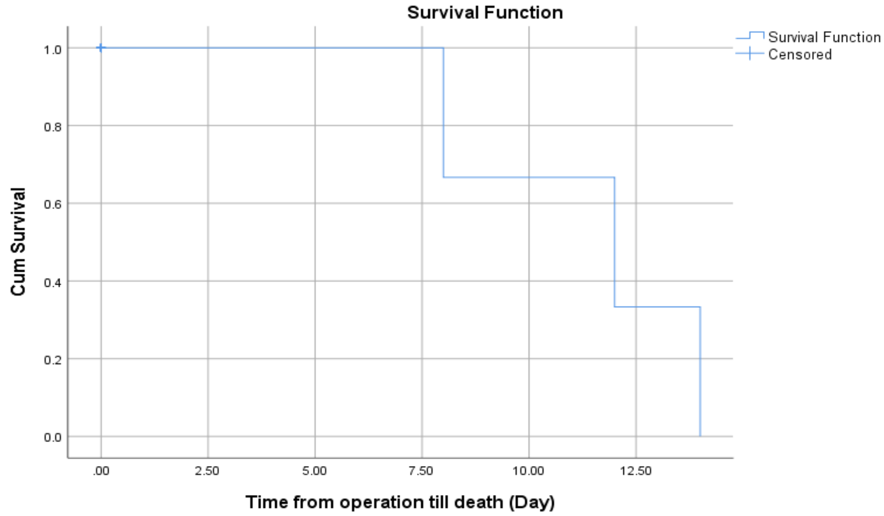

Figure (1): Kaplan–Meier survival curve of included subjects

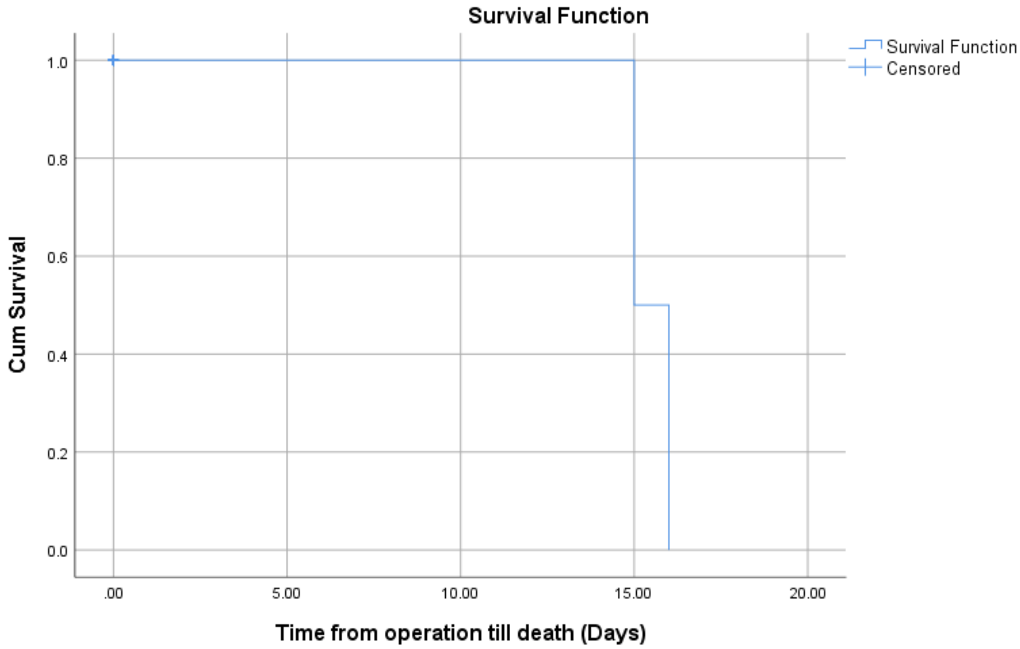

Figure (2): Kaplan–Meier survival curve of controls

Discussion

CABG, or coronary artery bypass grafting, is a common procedure for managing heart problems.[10]. Age-related ailments, such as hypertension, diabetes, atrial fibrillation, and chronic obstructive pulmonary disease, are common among the patients receiving these procedures in addition to coronary artery disease. Complications that may affect the postoperative prognosis after CABG are related to this multimorbidity and may include respiratory failure, stroke, postoperative psychosis, or acute renal injury.[11].

This study was conducted at Cardiothoracic Surgery Department, Zagazig University Hospitals. The study included 48 patients who underwent coronary artery bypass grafting (CABG) with mild to moderate symptomatic COPD and without Chronic obstructive pulmonary disease subdivided into two groups COPD (N = 24 and Non-COPD (N = 24).

As regard demographic data, we found that there was no significant difference in age, sex, BMI, or residence between individuals with COPD and those without COPD. However, smoking prevalence was significantly higher in individuals with COPD compared to those without COPD. This is likely attributable to smoking's negative effects on pulmonary functions, as the chance of getting COPD is proportional to both the number of cigarettes smoked per day and the number of years that a person has smoked, with heavy smokers being at a substantially higher risk. Smoking is the single most common cause of chronic obstructive pulmonary disease due to an inflammatory response triggered by the accumulation of inflammatory cells such as CD8+ T-lymphocytes, B cells, neutrophils, and macrophages.[12, 13].

Our findings are in agreement with the study by Huang et al. [14], which reported no discernible differences in demographic information between COPD and non-COPD groups. They also found a higher prevalence of smoking among COPD patients.

In this study, The COPD group had significantly lower values for all three pulmonary function tests (FEV1, FVC, and FEV1/FVC ratio) compared to the non-COPD group. Additionally, the COPD group had lower PaO2 and higher PaCO2 levels, indicating impaired gas exchange and potential respiratory acidosis.

Damage and inflammation of the airways associated with COPD can restrict air channels and cause the lungs to lose flexibility, both of which contribute to significantly lower scores in pulmonary function testing. As a result, people with COPD frequently experience diminished lung function and airflow. [15]

Our results were in agreement with Chen et al. [16] who found that basal spirometry, FEV1, and FVC values were all reported to be considerably lower in the COPD group compared to the non-COPD group

In this study, we found that the COPD group had a significantly longer cardiopulmonary bypass (CPB) time and aortic cross-clamping time compared to the non-COPD group ($P=0.00001$, $P<0.0001$ respectively). These findings suggest that COPD patients undergoing cardiac surgery may have a higher risk of prolonged CPB and aortic cross-clamping time, which may increase the risk of postoperative complications. The longer CPB and aortic cross-clamping time may also suggest a more complex surgery, which could be attributed to the presence of COPD and its associated comorbidities.

Due to decreased lung function and a higher risk of problems during cardiac surgery, individuals with COPD may need lengthier and more cautious procedures.[17].

Our findings are in agreement with the study by Gao et al. [18], which reported longer time in the ICU and hospital following CABG for COPD patients. They also reported that COPD patients had a higher risk of death.

Our results were in disagreement with Szylińska et al. [19] as they found no differences in CPB and aortic cross-clamping between COPD and non-COPD patients. The disagreement with

Szylińska et al. [19] may be due to differences in sample size, patient characteristics, surgical techniques, surgeon expertise, institutional practices.

In our study, The COPD group had significantly longer mechanical ventilation time, ICU stay, and total hospital stay compared to the non-COPD group. Additionally, the COPD group had a higher incidence of atelectasis but no significant difference in mortality compared to the non-COPD group.

Our findings indicate that COPD patients undergoing CABG require longer mechanical ventilation time and have extended stays in the ICU and hospital compared to non-COPD patients. This suggests a higher risk of respiratory complications and the need for prolonged care in COPD patients. The higher incidence of atelectasis in the COPD group can be attributed to their impaired lung function and prolonged ICU stay with mechanical ventilation [20].

Our results are in agreement with the studies by Gao et al. [18] and Angouras et al. [21], which reported longer ICU and hospital stays for COPD patients following CABG. The higher incidence of atelectasis in the COPD group is consistent with their impaired lung function and prolonged ICU stay with mechanical ventilation.

Our findings disagree with Szylińska et al. [19], who reported no significant difference in the length of hospital stay between COPD and non-COPD patients. The discrepancies in these findings may be attributed to variations in patient populations, surgical techniques, or other unaccounted factors.

In the current study, we found that Pulmonary function data in COPD group was significantly lower than non-COPD group ($P<0.05$) through time of the study (Pre-operative, at time of discharge and after 3 months from operation).

The significantly lower pulmonary function data, including FEV1, in the COPD group compared to the non-COPD group can be attributed to the underlying airway obstruction and inflammation characteristic of COPD. These factors restrict airflow, reduce lung elasticity, and lead to decreased lung function over time.

Our results were in agreement with Campo et al. [22] who reported that COPD was significantly associated with decline in FEV1 and Pulmonary function data.

Similarly our results were in agreement with, Melikulov et al. [23] reported that A predicted forced expiratory volume in one second (FEV1) below 60% is associated with an increased risk of respiratory problems following surgery and poor long-term outcomes after revascularization.

Strength and limitations of the study

The inclusion of a control group, various outcome measures, and a longitudinal methodology are only a few of the study's many merits. Another is its emphasis on the influence of mild to moderate symptomatic COPD on early morbidity and death following CABG. This allows for direct comparisons, provides a full analysis of recovery, and tracks changes over time to assess long-term recovery and prognosis for COPD patients who have undergone CABG surgery.

A limited sample size, a retrospective approach, and a single-center setting may all reduce the generalizability of our findings. The study only looked at people with mild to moderate COPD and didn't investigate any long-term results or the impact of other factors. These are all questions that need to be explored further in order to fully grasp the effects of COPD on CABG patients.

Conclusion

In this study, we show how COPD contributes to early mortality and morbidity after CABG surgery. Because of their poor lung function and limited respiratory capacity, patients with COPD who undergo CABG surgery typically require more time on mechanical ventilation, spend more time in the intensive care unit, and spend more time in the hospital overall. Postoperative complications may be more likely to occur in these patients because of the potential for longer durations of cardiopulmonary bypass and aortic cross-clamping. The increased morbidity associated with COPD suggests a need for closer monitoring and more aggressive management of these patients in the perioperative phase, despite the fact that we did not find a statistically significant difference in death between the two groups.

Conflicts of Interest: The authors declare no conflict of interest.

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