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Original Research Article

POSTOPERATIVE PULMONARY COMPLICATIONS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS UNDERGOING ABDOMINAL SURGERY IN A TERTIARY CARE INSTITUTE

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Abstract

Background: As per world Health Organization (WHO) COPD is the third leading cause of death worldwide. COPD is a well-known independent risk factor for the development of postoperative pulmonary complications (PPC) after abdominal surgery. The aim is to study the various factors associated with the development of PPC in COPD patients undergoing abdominal surgery. Settings and design are a prospective observational study was done at the department of Respiratory Medicine, at a tertiary care center. **Materials and Methods:** After applying inclusion and exclusion criteria, 249 consecutive COPD patients were included in the study. Prior to surgery, patients' demographic information, respiratory symptoms, and dyspnea severity as measured by the mMRC grade were noted. Information regarding the exposure to biomass fuel and smoking, recent respiratory infections, COPD exacerbations, and hospitalizations was collected. Patients' body mass index (BMI) was noted and the American Society of Anesthesiologists (ASA) classification was used to determine their overall health status. Investigations such as ECG, echocardiography, spirometry, hemoglobin, blood sugar, and chest x-ray were done. For predicting PPC, the ARISCAT risk indicator was used. The kind of anesthesia (general or neuraxial blockade), the location of the surgical incision (upper or lower abdomen), the length of the procedure, and the type of surgery (laparoscopy or laparotomy) were all noted. Any intraoperative complications were also noted. The patient was monitored from surgery till discharge for the development of any PPC. The length of the patient's ICU hospitalization and overall hospital stay were recorded. Statistical analysis is continuous variables were calculated using mean and standard deviation. Frequency in percentage was calculated for categorical variables. The Chi-squared test was used to compare the qualitative variables. A correlation was considered statistically significant if its P value was less than 0.05. **Result:** Out of 249 COPD patients who underwent elective abdominal surgery, 57 (22.9%) developed PPC, and the most common was respiratory failure followed by pneumonia or atelectasis. Nearly half of the patients (45%) had more than one complication, and 21% had both respiratory failure and pneumonia. The development of PPC was significantly associated with smoking status, higher mMRC grade of dyspnea, a history of recent respiratory infections and exacerbations, severity of lung impairment (FEV1 % ≤ 50 predicted), ≤ 95% oxygen saturation at room air, a higher ASA class, use of general anesthesia and upper abdominal surgery. The ARISCAT score index was found to have 17.8% predictability for PPC in our study. **Conclusion:** In our study, nearly a quarter of COPD patients who underwent abdominal surgery developed complications. In COPD patients undergoing upper abdominal surgery preoperative risk assessment using ASA classification and the ARISCAT risk index is helpful in predicting the occurrence of PPC.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a leading cause of morbidity and mortality worldwide.[1] The global prevalence of COPD is estimated to be 11%, and it is a common co-morbidity in patients undergoing surgery.[2] COPD is a well-known independent risk factor for the development of postoperative pulmonary complications (PPC) after abdominal surgery. From various studies, the incidence of PPC in COPD patients undergoing abdominal surgery is between 15%-30%.[3–6] In India, the prevalence of COPD is around 4% and the incidence of PPC in COPD patients undergoing abdominal surgery is as high as 30%.[7,8]

The most common PPC in COPD patients undergoing abdominal surgery is respiratory failure, followed by pneumonia and atelectasis. Many factors are associated with the development of PPC. They include preoperative factors (chronic lung disease, smoking, age, obesity, nutritional status, antecedent respiratory tract infection, general health status, preoperative Spo2 and haemoglobin level) and intraoperative factors (emergency nature of the procedure, type and duration of anaesthesia, location of the surgical site, type of surgical incision, intraoperative blood transfusion).[2]

Apart from morbidity and mortality, PPC also results in a longer hospital stay, leading to increased morbidity, mortality, and cost to the patients. Studies have reported that mortality due to PPC was 6.7% in COPD patients.[3,4]

MATERIALS AND METHODS

This was a cross-sectional observational study conducted between April 2016 and June 2017 at a tertiary care institute. Consecutive COPD patients who underwent elective abdominal surgery were included in the study. A diagnosis of COPD was established based on the GOLD 2016 guidelines. Patients undergoing emergency surgery with an active or past history of pulmonary tuberculosis, restrictive lung diseases, obstructive sleep apnea, severe renal and liver disease, and cardiac disease were excluded from the study. Informed consent was obtained from all the participants. The study was approved by the institute ethics committee (ECR/270/Inst./TN/2013 dated March 1, 2016).

Preoperatively, patients' demographic details, respiratory symptoms, and severity of dyspnea using the mMRC grade were collected. Patients were also asked about the history of smoking and biomass fuel exposure, respiratory infections in the past month, COPD exacerbations, and hospitalizations in the past year. A history of co-morbidities such as diabetes and hypertension were noted. Patients' body mass index (BMI) was calculated, and their general health status was assessed using the American Society of Anesthesiologists (ASA) classification. Investigations such as chest x-ray, hemoglobin, blood sugar, electrocardiogram, echocardiogram, and spirometry were done. The ARISCAT risk index was used to predict PPC.

Intraoperative details such as the type of anaesthesia (general or neuraxial blockade), surgical incision site (upper or lower abdomen), duration, and mode of surgery (laparoscopy or laparotomy) were noted. A requirement for an intraoperative blood transfusion was noted. Any intraoperative complications were also noted.

Postoperatively, the patient was followed up until discharge from the hospital for any pulmonary complications. The duration of the ICU stay and total hospital stay were noted.

Statistical Analysis

The collected data was entered into a Microsoft Excel worksheet and analyzed using Statistical Package for Social Sciences (SPSS) software version 21.0. Continuous data are presented as means and standard deviations. The chi-squared test was used to compare the qualitative variables. The significance of the correlation between variables was assessed using a P value. A correlation was considered statistically significant if its P value was less than 0.05.

RESULTS

Two hundred and forty-nine COPD patients who underwent elective abdominal surgery and gave consent to participate were enrolled in the study. Out of 249 COPD patients who underwent elective abdominal surgery, 57 (22.9%) developed PPC, and the most common was respiratory failure followed by pneumonia or atelectasis. The results are summarized in [Table 1].

Out of 57 patients who developed PPC, 26 had respiratory failure (which includes 20 patients on mechanical ventilation for > 48 hours and 6 patients who had unplanned intubation), 22 had pneumonia or atelectasis, nine had an exacerbation of COPD, three had pleural effusion, one developed a pulmonary embolism, and three patients died. Nearly half of the patients (45%) had more than one complication, and 21% had both respiratory failure and pneumonia. [Figure 1] gives a break up of the PPC observed in the study.

a) Age and Sex

Out of 249 patients, 194 were male and 55 were female. The mean age was 56.63 ± 8 years, and the majority of the patients (109, 43.8%) were in the 50–59-year age group. We observed that a higher age (≥ 60 years) was associated with a higher risk of developing PPC (p 0.04). Male patients (23.7%) had a slightly higher rate of PPC compared to females (20%), but the difference was not statistically significant (p 0.563).

b) mMRC Grade

It was observed that the PPC was significantly associated with higher preoperative mMRC grade (p 0.001). Forty-one percent of patients with grade 3

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mMRC, 31.5% with grade 2 mMRC, 14.9% with grade 1 mMRC, and 5.3% with grade 0 mMRC developed PPC.

c) History of exacerbations, hospitalizations and respiratory infections

Ninety-one patients (36.54%) had a history of exacerbations in the last year, and 39 patients had a history of hospitalization and more than one exacerbation. We found that 48% of the patients with a history of two exacerbations, 35.3% with one exacerbation, and 10.8% with no exacerbation developed PPC. We also found that 71.8% of the patients with a history of ≥ 1 hospitalization developed PPC. There was a statistically significant increase in PPC in patients with more than one exacerbation (p 0.001) and a history of ≥ 1 hospitalization (p 0.001).

PPC was significantly increased in patients with a history of respiratory tract infection in the previous month (p 0.005). Fifty-eight patients (23.3%) had a history of respiratory infections in the previous month, of which 23 (39.7%) developed PPC.

d) Smoking status

One hundred and twenty-three patients (49.4%) were former smokers, 56 (22.5%) were current smokers, and 70 patients (28.1%) were never smokers. Among the patients with a history of smoking, the majority (n = 84) had 1 to 20 pack years of smoking, and 25 patients had ≥ 40 pack years of smoking.

Our study showed that 22 out of 56 (39.3%) current smokers, 24 out of 123 (19.5%) former smokers, and 11 out of 70 (15.7%) never smokers developed PPC. There was a statistically significant increase in PPC in current smokers (p 0.003).

Twelve out of 25 (48%) patients with ≥ 40 pack years, 23 out of 67 (34.3%) with 21-39 pack years, and 11 out of 84 (13.1%) with 1-20 pack years developed PPC. There was a statistically significant increase in PPC in patients with ≥ 40-pack-year smoking history. (p < 0.001).

e) Severity of lung function impairment

Airflow limitation assessed based on postbronchodilator FEV1% predicted revealed that the majority of the patients (175, 70.3%) had moderate obstruction. Mild obstruction was seen in 16 patients (6.4%), severe obstruction in 53 patients (21.28%), and only 5 patients (2%) had very severe obstruction. Postoperative complications were seen in 1 out of 16 patients (6.25%) with mild obstruction, 31 out of 175 patients (17.7%) with moderate obstruction, 22 out of 53 patients (41.5%) with severe obstruction, and 3 out of 5 patients (60%) with very severe obstruction. There was a statistically significant increase in PPC in patients with FEV1 ≤ 50% predicted (p 0.005). The results are summarized in [Table 2].

f) Preoperative oxygen saturation

Preoperatively, oxygen saturation (SpO2) was recorded using pulse oximetry for all the patients. Ten patients had oxygen saturation between 91 and 95%, 239 patients had oxygen saturation ≥ 96%, and no patient had saturation below 91%. Fifty percent of patients with oxygen saturation (Spo2) between 91-95 %, and 21.8% with oxygen saturation of ≥ 96% had PPC. There was a statistically significant increase in PPC when the preoperative oxygen saturation was ≤ 95% (p 0.037).

g) ASA physical status classification

In our study, 8 patients (3.2%) were in ASA I, 184 (73.9%) were in ASA II, 52 (20.9%) were in ASA III, five (2%) were in ASA IV, and no patients were in ASA V or ASA VI. No patients with ASA I developed PPC. Whereas 2 out of 5 (40%) of patients in ASA IV, 23 out of 52 (44.2%) in ASA III, and 32 out of 184 (17.4%) in ASA II had PPC. A higher ASA class was significantly associated with an increase in PPC (p 0.001).

h) Type of anaesthesia, site of incision, mode and duration of surgery

One hundred and thirty patients (52.2%) underwent surgery under general anaesthesia and 119 patients (47.8%) underwent surgery under neuraxial blockade. Among the patients who underwent surgery under general anaesthesia and regional anaesthesia, 33.8% and 10.9% had PPC, respectively. Patients who had surgery under general anaesthesia had a significant increase in PPC (p < 0.001) compared to those who received regional anaesthesia.

Sixty-one (24.5%) patients underwent laparoscopic abdominal surgery, and 188 (75.5%) underwent laparotomy. Among the patients who underwent open abdominal surgery (laparotomy) and laparoscopic surgery, 28.2% and 6.6% of patients had PPC, respectively. There was a statistically significant decrease in PPC when the patient underwent laparoscopic abdominal surgery (p value < 0.001).

One hundred and thirty-six (54.6%) patients had an upper abdominal surgical site incision, and 113 patients (45.4%) had a lower abdominal surgical site incision. 34.6% of patients with upper abdominal surgical site incisions developed PPC. There was a statistically significant increase in PPC when the patient had an upper abdominal surgical site incision (p value < 0.001).

Ninety-eight patients (39.4%) had a duration of surgery less than 2 hours, 81 patients (32.5%) had a duration of surgery between 2 and 3 hours, and 70 (28.1%) had a duration of surgery greater than 3 hours. Fifty-four percent of patients with a duration of surgery > 3 hours and 13.3% with a duration of surgery < 2 hours had PPC. There was a statistically significant increase in PPC when the duration of surgery wass > 3 hours (p value < 0.001).

i) Postoperative blood transfusion

Twenty-seven patients received intraoperative blood transfusion, of whom 19 (70.4%) developed PPC, compared to 38 (17.1%) out of 222 patients who developed PPC without any need for blood transfusion. It was observed that there was a statistically significant increase in PPC when intraoperative blood transfusion was ≥ 2 units (p value < 0.001).

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j) ARISCAT score

During preoperative evaluation, based on the ARISCAT score, 77 patients (30.9%) had a low risk, 154 (61.8%) had a moderate risk, and 18 (7.2%) had a high risk of developing PPC. Postoperatively, we found that 2 patients (2.6%) with low risk, 42 (27.3%) with moderate risk, and 13 (72.2%) with a high-risk score developed PPC. When multinominal logistical regression was used, it was observed that compared to those with low ARISCAT scores, high scorers had 97.5 odds (17.1 – 556.8) of developing PPC and moderate scorers had 14.06 (3.3 – 59.9) odds of developing PPC. The ARISCAT score index was found to have 17.8% predictability for PPC. The results are summarized in [Table 3].

k) Postoperative hospital stay

Patients who developed PPC had a longer hospital stay (13.72 ± 4.3 days) and ICU stay (3.14 ± 3 days) compared to those who did not develop PPC (4.38 ± 2.4 days and 0.21± 0.60 days respectively).

Patients' BMI, preoperative hemoglobin, pre-existing diabetes, and hypertension did not have any significant impact on the development of postoperative complications.

Table 1: Association of various factors with development of postoperative pulmonary complications

		Postoperative pulmonary complication				Chi sq p values
		YES		NO		
		n	%	n	%	
Age range	40 - 49 years	14	23.0%	47	77.0%	0.039*
	50 - 59 years	18	16.5%	91	83.5%	
	≥ 60 years	24	33.8%	47	66.2%	
Gender	Male	46	23.7%	148	76.3%	0.563
	Female	11	20.0%	44	80.0%	
mMRC grading	0	1	5.3%	18	94.7%	< 0.001*
	1	17	14.9%	97	85.1%	
	2	29	31.5%	63	68.5%	
	3	10	41.7%	14	58.3%	
FEV1 % predicted	≥ 80%	1	6.3%	15	93.8%	< 0.001*
	79 - 50%	31	17.7%	144	82.3%	
	49 - 30%	23	43.4%	30	56.6%	
	< 30 %	2	40.0%	3	60.0%	
No. of hospitalization	0	29	13.8%	181	86.2%	<0.001*
	1.0	26	70.3%	11	29.7%	
	2.0	2	100.0%	0	0.0%	
BMI range	< 18.5	4	28.6%	10	71.4%	0.104
	18.5 - 24.9	42	23.1%	140	76.9%	
	25 - 29.9	7	15.6%	38	84.4%	
	>= 30	4	50.0%	4	50.0%	
Smoking status	Current Smoker	22	39.3%	34	60.7%	0.003*
	Former Smoker	24	19.5%	99	80.5%	
	Never Smoker	11	15.7%	59	84.3%	
Pack years	<1	11	15.1%	62	84.9%	<0.001*
	1 - 20	11	13.1%	73	86.9%	
	21 - 39	23	34.3%	44	65.7%	
	>= 40	12	48.0%	13	52.0%	
Diabetes	Yes	5	27.8%	13	72.2%	0.19
	No	52	22.5%	179	77.5%	
Systemic hypertension	Yes	1	7.7%	12	92.3%	0.127
	No	56	23.7%	180	76.3%	
Spo2	≥ 96%	52	21.8%	187	78.2%	0.041*
	91 - 95%	5	50.0%	5	50.0%	
	≤ 90%	0	0.0%	0	0.0%	
Hemoglobin	≤ 10 g/dl	5	16.1%	26	83.9%	0.338
	> 10 g/dl	52	23.9%	166	76.1%	
ASA class	I	0	0.0%	8	100.0%	<0.001*
	II	32	17.4%	152	82.6%	
	III	23	44.2%	29	55.8%	
	IV	2	40.0%	3	60.0%	
Mode of surgery	Open	53	28.2%	135	71.8%	<0.001*
	Laparoscopy	4	6.6%	57	93.4%	
Type of anesthesia	General	44	33.8%	86	66.2%	<0.001*
	Regional	13	10.9%	106	89.1%	
Surgical incision site	Upper	47	34.6%	89	65.4%	<0.001*
	Lower	10	8.8%	103	91.2%	
Duration of surgery	< 2 hours	13	13.3%	85	86.7%	<0.001*
	2 – 3 hours	6	7.4%	75	92.6%	
	> 3 hours	38	54.3%	32	45.7%	

* P value < 0.05 was considered significant.

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Table 2: Degree of airflow limitation and postoperative pulmonary complications

Severity of COPD based on FEV1 % predicted	Postoperative Pulmonary Complication		Total	Fisher exact p value
	Yes	No		
Mild	1 (6.25%)	15 (93.75%)	16 (100%)	0.001*
Moderate	31 (17.7%)	144 (82.3%)	175 (100%)	
Severe	22 (41.5%)	31 (58.5%)	53 (100%)	
Very severe	3 (60%)	2 (40%)	5 (100%)	
Total	57 (22.9%)	192 (77.1%)	249 (100%)	

* P value < 0.05 was considered significant.

Table 3: Prediction of postoperative pulmonary complications by ARISCAT risk index

ARISCAT SCORE	B	Sig.	Odds ratio [exp(B)]	95% Confidence Interval for Odds ratio		McFadden R2
				Lower Bound	Upper Bound	
Intercept (CONSTANT)	3.624	0.0001				0.178
HIGH	4.580	0.0001	97.500	17.073	556.791	
MODERATE	2.644	0.0001	14.062	3.304	59.851	
LOW	0					

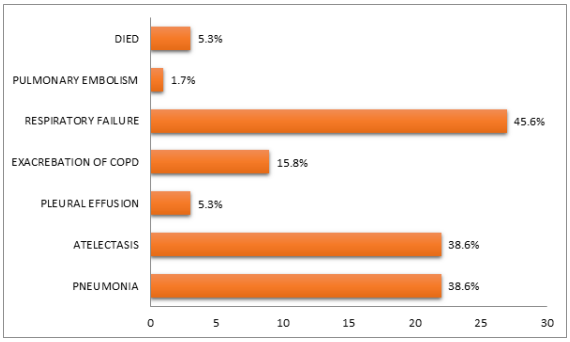

Figure 1: Type of postoperative pulmonary complications

DISCUSSION

In our study, the overall incidence of PPC in COPD patients who underwent elective abdominal surgery was 22.9%. The incidence of postoperative pulmonary complications in upper abdominal surgeries was 34.6%. Various studies have reported an incidence of PPC ranging from 7.9% to 22% in COPD patients undergoing abdominal surgery.[5,6,9,10] Wong et al. found that the incidence of PPC was 37%, with high long-term mortality in severe COPD patients.[11]

Respiratory failure (45.6%) was the most common complication observed in our study population, followed by atelectasis or pneumonia (38.6%) which is similar to the observations made in other studies.[3,11] However, pneumonia, followed by atelectasis and respiratory failure, was observed as the common PPC in some studies.[12,13] Pleural effusion was the most common PPC observed in a study by Harshavardhan et al.[8] There may be individual differences in the study population and type of surgery, leading to differences in the incidence of various complications.

Studies have shown that advanced age, a higher preoperative dyspnea grade by mMRC, a history of respiratory tract infection in the previous month, ≥ 2 exacerbations or ≥ 1 hospital admission due to respiratory problems in the previous year had a significant risk for the development of postoperative pulmonary complications.[5,12,14–16] Similar findings were observed in our study. BMI is not significantly associated with the development of PPC or the length of the ICU stay following abdominal surgeries.[17,18] We found no correlation between BMI and the development of PPC.

Current smoking is associated with a nearly six-fold increase in the risk of developing PPC, and longer periods of smoking cessation may reduce the incidence of PPC.[19,20] In a meta-analysis, preoperative smoking was associated with an increased risk of PPC, with a relative risk of 1.73.[21] In our study, current smoking was significantly associated with the development of postoperative pulmonary complications, and nearly half of the patients (48%) with ≥ 40 pack years of smoking developed PPC.

The ASA status of the subjects in the study population had a significant linear association with the development of PPC.[5] Wong et al,[11] reported that 75% of patients with ASA IV developed PPC, whereas in our study, 60% of individuals with ASA IV developed complications. We also used the ARISCAT risk index to predict the PPC among the subjects and observed that 72% of the subjects with high-risk score and 27% with an intermediate risk score had PPC. Kupeli et al. reported that among high-risk score subjects, 75% developed PPC and among intermediate risk score subjects, 20% developed PPC. They also concluded that the ASA classification was found to be a weaker modality to predict PPC compared to the ARISCAT risk index.[22] In our study, when adjusted for other factors, the ARISCAT score had 17.8% predictability for PPC.

There is a strong correlation between the severity of COPD and the development of PPC. Studies have shown that the incidence of PPC among mild to moderate and severe COPD is 12% and 37%, respectively.[5,11] Fuso et al. found that a FEV1 < 61% of predicted was a main determinant for developing PPC.[23] In our study, the incidence of PPC was 20.12%, 22%, and 60% in the subjects with mild to

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moderate, severe and very severe airflow limitation respectively. We found a statistically significant increase in PPC in patients with FEV1 ≤ 50% predicted.

The site (upper or lower abdomen), duration of surgery, and mode of surgery (open or laparoscopic) have an impact on the development of PPC. Studies have demonstrated that upper abdominal surgery, long duration of surgery, and emergency surgery lead to a higher incidence of PPC.[5,9] Our analysis revealed a significantly increased PPC in patients who required general anaesthesia. PPC was also higher among the patients who underwent upper abdominal surgery, and laparoscopic surgery was associated with significantly lower PPC compared to open laparotomy. The duration of surgery > 2 hours is independently associated with the development of PPC, and the risk of PPC increases with every additional minute, independent of other factors.[10,14,24] Wong et al. found that 61% of the patients developed PPC when the duration of surgery was > 4 hours.[11] More than half of the patients in our study developed PPC when the surgery duration was > 3 hours.

A preoperative oxygen saturation < 96% and intraoperative blood transfusion are independently associated with the risk of developing PPC.[14] This stands true in our study, as we found that the patients who received blood transfusions during surgery and those who had oxygen saturation ≤ 95% had a significant association with the incidence of PPC.

We found no significant correlation between anemia, co-morbidities such as diabetes and hypertension, and the development of PPC. Although a study reported that patients with preoperative anemia (Hb <10 g/dl) had a three-fold increase in risk of developing PPC, the difference in the association may be attributed to the higher number of emergency surgeries included in that study.[14] As reported by other studies, we too found that PPC resulted in a longer post-surgery hospital and ICU stay.[3,10]

Limitations

This was a cross sectional study performed at a single center, and no controls were included. Emergency surgeries were excluded from the study because of the difficulty in diagnosing COPD using spirometry in those patients.

CONCLUSION

Respiratory failure, followed by pneumonia, was the most common PPC observed in the study. The development of PPC was significantly associated with a higher age, higher mMRC grades, COPD severity, smoking history, and low preoperative oxygen saturation. The use of general anaesthesia, upper abdominal surgery, open laparotomies, and a longer duration of surgery are associated with a high risk of developing PPC. Preoperative risk assessment using ASA classification and the ARISCAT risk index is helpful in predicting the occurrence of PPC.

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