Monaldi Archives for Chest Disease

eISSN 2532-5264 https://www.monaldi-archives.org/

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Monaldi Arch Chest Dis 2024 [Online ahead of print]

To cite this Article:
Garg S, Govindaraj V, Dwivedi DP, et al. **Postoperative pulmonary complications in patients undergoing upper abdominal surgery: risk factors and predictive models.** *Monaldi Arch Chest Dis* doi: 10.4081/monaldi.2024.2915

Postoperative pulmonary complications in patients undergoing upper abdominal surgery: risk factors and predictive models

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Contributions: SG, GV, DPD, KS, TP, resources, data curation, investigation, writing-original draft; SG, GV, writing-review and editing; GV, supervision; SG, GV, visualization.

Conflict of interest: the authors declare no potential conflict of interest.

Ethics approval and consent to participate: ethical committee approval was taken before the commencement of this study (JIP/IEC/2021/250).

Informed consent: informed consent was also obtained from the patients included in the study.

Funding: none.

Availability of data and materials: all data underlying the findings are fully available.

Abstract

Postoperative pulmonary complications (PPCs) are unexpected disorders that occur up to 30 days after surgery, affecting the patient's clinical status and requiring therapeutic intervention. Therefore, it becomes important to assess the patient preoperatively, as many of these complications can be minimized with proper perioperative strategies following a thorough preoperative checkup. Herein, we describe the PPCs and risk factors associated with developing PPCs in patients undergoing upper abdominal surgery. Additionally, we compared the accuracy of the American Society of Anaesthesiologists (ASA) score, the Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT) score, the 6-Minute Walk Test (6MWT), and spirometry in predicting PPCs. Consenting patients (>18 years) undergoing elective upper abdominal surgery were recruited from November 2021 to April 2023. Clinical history was noted. Spirometry and 6MWT were both performed. Pre-operative ASA and ARISCAT scores were recorded. Postoperative follow-up was conducted to assess respiratory symptoms and the occurrence of PPC. PPC was defined as per EPCO guidelines. A total of 133 patients were recruited, predominantly male. A total of 27 (20.3%) patients developed PPCs. A total of 14 (10.5%) patients had more than one PPC. The most common PPCs developed were pleural effusion (11.3%), respiratory failure (7.5%), and pneumonia (4.5%). We obtained ten statistically significant associated variables on univariable analysis, viz obstructive airway disease ($p=0.002$), airflow limitation ($p=0.043$), chest radiography ($p<0.001$), albumin ($p=0.30$), blood urea nitrogen (BUN) ($p=0.029$), aspartate aminotransferase ($p=0.019$), alanine aminotransferase ($p=0.009$), forced expiratory volume in one second/forced vital capacity ratio ($p=0.006$), duration of surgery ($p<0.001$), and ASA score ($p=0.012$). On multivariable regression analysis, abnormal chest radiograph [odds ratio: 8.26; (95% confidence interval: 2.58-25.43), $p<0.001$], BUN [1.05; (1.00-1.09), $p=0.033$], and duration of surgery [1.44; (1.18-1.76), $p<0.001$] were found to be independently associated with PPC. The ASA score was found to have better predictive power for the development of PPCs compared to the ARISCAT score but is of poor clinical significance. Additionally, 6MWD and spirometry results were found to lack any meaningful predictive power for PPC. To conclude, preoperative evaluation of the chest radiograph, BUN, and duration of surgery are independently associated with developing PPCs. The ASA score performs better than the ARISCAT score in identifying patients at a higher risk of developing PPCs and implementing preventive measures.

Key Words: postoperative pulmonary complications, ARISCAT score, ASA score, spirometry, six-minute walk test, upper abdominal surgery

Introduction

Postoperative Pulmonary Complication (PPC) refers to a wide range of unfavourable respiratory system changes that occur following surgery and impact the patient's clinical course [1]. Pulmonary complications remain the second most encountered problem post-operatively, with surgical site infection being the first [2]. PPC encompasses a spectrum of respiratory issues such as pneumonia, aspiration pneumonitis, pleural effusion, respiratory failure, atelectasis, pneumothorax, bronchospasm, acute respiratory distress syndrome, and pulmonary embolism [3].

Various tests and scores have been used to evaluate patients pre-operatively to assess or predict PPCs. These include spirometry, a Six-Minute Walk Test (6MWT), and scores like The American Society of Anesthesiologists Physical Status (ASA PS) classification system [4], and ARISCAT (Assess Respiratory Risk in Surgical Patients in Catalonia) score [5].

PPCs increase the patient's morbidity, mortality, and length of hospital stay, adding to the financial burden on the patient's family. Therefore, it becomes important to assess the patient preoperatively, as many of the complications can be minimized with proper perioperative strategies following a thorough preoperative checkup.

Multiple risk factors lead to PPC, including age, co-morbidities, type of surgery, intraoperative events, type of anaesthesia, and the patient's pre-pulmonary status.

Multiple studies have been done to assess the risk factors associated with PPC. However, few studies use multiple assessment methods like the 6MWT, spirometry, ASA score, and ARISCAT score for pre-operative evaluation.

With this perspective, we undertook this study to evaluate the pulmonary status of patients undergoing elective upper abdominal surgery. We followed them up to look for the development of PPC and correlate pre-operative parameters with PPC. We also compared the accuracy of the ASA score, ARISCAT score, 6MWT, and spirometry in predicting PPC.

Materials and Methods

A cohort study was conducted from November 2021 to April 2023 in a tertiary care center in South India after the Institutional Ethics Committee approval (JIP/IEC/2021/250).

Patients above 18 years of age undergoing elective upper abdominal surgery referred to pulmonary medicine were screened (175 patients). The patients who could not perform/had contraindications for spirometry or 6MWT and undergoing daycare procedures were excluded. After obtaining consent from the patient. Patients' demographics and detailed clinical history were noted, and a pre-operative chest radiograph was taken. Spirometry was performed using a COSMED PONY FX (Cosmed, made in Italy, 2019) machine by a trained technician as per ATS guidelines [6]. A 6MWT was conducted following American Thoracic Society guidelines

[7]. ASA and ARISCAT scores were calculated[4,5]. Patients were followed up till 30 days postoperatively, and any symptoms of PPC were assessed daily for 7 days postoperatively, followed by twice weekly for one month. Patients were classified into PPC and non-PPC groups for risk factor analysis.

Statistical analysis

With an expected incidence of 15% PPC [8], and 7% absolute precision, an initial estimate of 100 was made. Assuming 10 % lost to follow-up, a corrected sample size of 110 was obtained. Categorical data were presented as frequency and percentage. Continuous data with normal distribution were presented as mean, standard deviation, and skewed distribution as median and interquartile range.

Continuous variables were compared using an independent sample t-test and Mann-Whitney U-test. The Pearson chi-square test and Fischer exact test assessed the association of categorical variables related to clinical/patient characteristics and surgical procedure with PPC. The risk factors for developing PPC were assessed by multivariable logistic regression analysis by a forward method using factors identified with a p-value < 0.05 in univariable analysis. The cut-off value was calculated using ROC, and cross tabs were created to find the sensitivity and specificity. The Analysis was performed using IBM-SPSS version 19.0 (IBM-SPSS Science Inc., Chicago, IL), and a p-value < 0.05 was considered statistically significant.

Results

A total of 175 patients undergoing upper abdominal surgery were screened for inclusion. Of these, 42 patients were excluded, and 133 were recruited and analysed for the study. (Figure 1)

The male and female ratio was almost equal. Most patients were more than 61 years of age (26.3%), about one-fourth were smokers (27.1%), one-third were exposed to biomass fuel, and 28.6% had diabetes mellitus.

All patients had an ASA score of 3 (24 patients with an ASA score of 4 or 5 could not perform spirometry, hence excluded). Most (52.6%) patients had an ASA score of 3. As per the ARISCAT score, 14 (10.5%), 84 (63.2%), and 35 (26.5%) patients belonged to low, intermediate, and high-risk categories, respectively. The most frequent surgery performed was gastric surgery in 30 (22.6%) patients, followed by pancreatectomy in 23 (17.3%) patients (Table 1). Most patients, 96 (72.2%), underwent open surgery. Seventy-three (54.9%) patients had benign conditions, and 60 (45.1%) had malignant conditions.

Postoperative pulmonary complications

Of 133 patients, 27 (20.3%) developed pulmonary complications. The details related to PPCs are given in Table 2. Fourteen (10.5%) patients had more than one pulmonary complication. The most common PPC was pleural effusion in 15 (11.3%) patients, and the most common isolated PPC was pneumonia in 6 (4.5%) patients. The most frequent postoperative complaint was fever in 26 (19.5%) patients, followed by dyspnoea in 25 (18.8%). Only 3 (2.3%) patients complained of haemoptysis postoperatively.

The majority of patients, 25 (92.6%), developed pulmonary complications within 7 days of surgery [15 (55.6%) patients within 48 hours]. The duration of hospital stay postoperatively was significantly prolonged in patients with PPCs [Median (Q1, Q3)] [15 (9,19)] compared to patients without PPCs [6 (4,9)] ($p<0.001$) (Table 3).

Risk factors

Our study participants were categorized into patients with and without PPCs, and univariable analysis was performed to assess PPC risk factors (Tables 3 and 4). There was no statistically significant difference between variables of age, sex, smoking status, and biomass fuel exposure status. On comparing comorbidities, only OAD had a statistically significant difference ($p=0.002$). Abnormal chest radiographs showed a statistically significant difference ($p<0.001$). On comparing laboratory parameters, results showed that the haemoglobin level (median [Q1, Q3]) was 11.1 [8.7,12.4] and 11.70 [9.5,13] ($p=0.07$) among patients with and without PPC, respectively. The albumin level was significantly lower in patients with pulmonary complications ($p=0.03$). The blood urea nitrogen level, AST, and ALT values were significantly higher in patients who developed PPCs with p-values of 0.029, 0.019, and 0.009, respectively (Table 3).

On comparing procedure-related risk factors, the duration of surgery in patients with PPCs was significantly prolonged compared to those without PPCs ($p<0.001$). However, laparoscopic surgery did not reduce the prevalence of PPC in the present study. Patients who underwent surgery for non-oncological and oncological indications had similar incidences of PPCs.

In spirometric parameters, only FEV1/FVC ratio showed a statistically significant difference in patients with and without PPC, with a P value of 0.006 (Table 5).

The six-minute walk distance (median [Q1, Q3]) among patients with and without PPC was 320 [290,400] meters and 370 [320,400] meters, respectively ($p=0.127$) (Table 3).

There was no significant difference in ARISCAT score among patients with and without PPC (median [Q1, Q3]) 41 [38,50] and 38 [33.25, 42.75], respectively ($p=0.061$) (Table 3).

In our study, only 2 patients had an ASA score of 1, so they were included in the ASA score 2 group for analysis. Twenty (28.6%) patients in the ASA score 3 group developed pulmonary complications. In contrast, only 7 (11.1%) patients with an ASA score of 1 or 2 developed pulmonary complications. The result showed a significant difference in ASA scores between patients with and without pulmonary complications (p=0.012) (Table 4).

The following risk factors for PPCs were identified on multivariable logistic regression by the forward method: Chest radiograph [8.26, (2.58-26.43), p<0.001], BUN [1.02, (1.00-1.09), p=0.03] and duration of surgery [1.44, (1.18-1.76), p<0.001] (Table 6).

Receiver operating characteristic analysis to compare spirometry parameters, Assess Respiratory Risk in Surgical Patients in Catalonia score, 6-Minute Walk Test in predicting postoperative pulmonary complications

On Receiver Operating Characteristic (ROC) analysis, the Area Under the Curve (AUC) for ARISCAT score and FVC (%) was 0.616 and 0.538, respectively (Figure 2). ARISCAT score had a relatively better predictive ability than FVC (%). However, at a cut-off value of 39.5, the sensitivity and specificity of the ARISCAT score were only 63% and 57%, respectively, indicating poor clinical significance (Table 7). FEV1 (%), FEV1/FVC ratio, and 6MWD had an AUC of 0.428, 0.318, and 0.405, respectively, suggesting no clinical utility (Table 7).

American Society of Anaesthesiologists score

For calculation of sensitivity and specificity, the patients with a score of 3 were considered as the positive group (those who developed complications), and those with a score less than 3 as the negative group (those who did not develop complications). A sensitivity of 74.1% and specificity of 52.8% were obtained.

ASA score had relatively better predictive ability than spirometry, ARISCAT score, and 6MWT, but of little clinical significance.

Discussion

Baseline characteristics

The study included 133 patients undergoing elective upper abdominal surgery, with most patients above 61 years of age. The occurrence of PPCs was not significantly influenced by increasing age, contrary to previous findings in the literature [3,9]. In our study, younger patients underwent more extensive surgery compared to older age group, explaining the discrepancy in our result.

This study comprised 133 patients with a balanced proportion of male and female patients, with no statistically significant difference among occurrence of PPC, similar to Johnson et al. [10]. Smoking history and biomass fuel exposure did not show a significant association with PPCs, possibly due to the small sample size of smokers in the study. The existing data regarding the association between smoking and PPC are varied, but they generally indicate a modest increase in risk among current smokers [11-13].

Comorbidities

Though diabetes mellitus was the most common comorbidity observed, Obstructive Airway Disease (OAD) was significantly associated with an increased risk of PPCs, similar to the findings in past literature [2,9,14,15]. The reduced lung function, increased susceptibility to infections, impaired respiratory muscle strength and usage of inhaled corticosteroids can explain this increased incidence of PPCs in OAD patients [16,17].

Prevalence of postoperative pulmonary complications

Approximately twenty percent of cases developed PPCs, with pleural effusion (11.3%) being the most common complication. Similarly, Gülsen et al. found a PPC rate of 36.8%, with pleural effusion (18.5%) being the most common PC [18]. A study by Tilak et al. showed pneumonia as the most common complication [19]. According to a study by Kroell et al., respiratory failure was identified as the most prevalent complication among patients who developed PPCs, occurring in 15.53% of cases [20].

Most PPCs occurred within 48 hours of surgery, similar to the finding of Fernandes et al. [21], emphasizing the importance of vigilant monitoring in the early postoperative period.

Risk factors

Operative method

The operative method (open vs. laparoscopic surgery) did not significantly influence the occurrence of PPCs. This finding was similar to that of Numata et al. [22]. In contrast, a meta-analysis comparing laparoscopic gastrectomy with open gastrectomy by Jiang et al. reported fewer PPCs with preserved lung function in the laparoscopic group [23]. Similarly, Boni et al. demonstrated that laparoscopic surgical procedures positively impact the preservation of the immune system, leading to a reduced proinflammatory cytokine response [24]. As a result, the infection rate, including infections in the pulmonary system, was lower in laparoscopic surgery than in open surgery. The disparity in our result can be explained by the small number of patients who underwent laparoscopic surgery. With a small sample size, even if there are real differences between the groups, they might not reach statistical significance.

In our study, we demonstrated, after multivariable analysis, several independent risk factors for PPCs, including abnormal preoperative chest radiograph, elevated Blood Urea Nitrogen (BUN), and prolonged duration of surgery with an odds ratio of 8.26 [95% CI: 2.58-26.43], 1.05 [95% CI: 1.00-1.09] and 1.44 [95% CI 1.18-1.76].

Patients with abnormal chest radiographs were approximately eight times more likely to experience PPCs in our study. Similarly, Verma et al. demonstrated that pre-operative abnormal chest X-ray changes were three times more common in the PPCs group than in the control group without PPCs [25]. This finding suggests that preoperative chest radiograph evaluation is useful for identifying patients at a higher risk of developing PPC and implementing preventive measures.

Each unit increase in BUN level was associated with a 5% increased risk of PPCs. Similarly, in a study by Arozullah et al., it was observed that patients with a preoperative BUN level exceeding 40 mg/dL had an odds ratio (OR) of 2.4 for development of PPC (95% CI, 2.0-2.8) compared to those with a BUN level below 20 mg/dL [26]. The correlation between BUN levels and PPCs may suggest that patients with underlying renal dysfunction or insufficient fluid balance are more likely to experience pulmonary complications after surgery [27,28]. This finding highlights the significance of perioperative kidney function and fluid status monitoring to reduce the risk of PPC.

Additionally, the risk of PPCs increased by approximately 44% for each additional hour of surgery. The ACP guidelines also classify prolonged surgeries as a risk factor with good evidence but do not specify what duration increases the risk [29]. ARISCAT score also considers the duration of surgery for stratifying patients into various risk classes [5]. Prolonged surgical procedures may result in increased tissue trauma, prolonged mechanical ventilation, and immobility, all of which can contribute to developing PPCs. When possible, measures to minimize the duration of surgery should be taken while ensuring appropriate and safe surgical interventions to reduce PPCs.

The predictive power of the 6-Minute Walk Test, Assess Respiratory Risk in Surgical Patients in Catalonia score, American Society of Anaesthesiologists score, and spirometry

In this study, ASA score >2 had better sensitivity than the ARISCAT score in predicting the development of PPCs, 74.1% vs 63%. However, the specificity of these scores was comparable: 52.8% and 57% for ASA and ARISCAT scores, respectively, suggesting poor clinical significance. In contrast, Sibel Kara et al. demonstrated that ASA classification exhibited weaker predictive ability than the ARISCAT risk index in forecasting PPC following upper and lower abdominal surgeries [30]. ARISCAT score does not consider associated comorbidities that might influence PPC development. However, ASA does address those. Age was not significantly associated with PPC in our study, but it was considered in the ARISCAT score, which might explain the observed finding.

We obtained a cut-off value of 39.5 for the ARISCAT score and 75.5% for the predicted FVC (%). ARISCAT score had a relatively better predictive power than predicted FVC (%) (AUC

0.616 vs 0.538). We concluded that FEV1, FEV1/FVC ratio and 6MWT have no predictive ability (AUC 0.428, 0.318, and 0.405, respectively). Similarly, Oh et al. also demonstrated that preoperative spirometry could not be used to stratify the risk of PPCs in older patients undergoing laparoscopic gastrectomy [31].

To the best of our knowledge, this was the second study to describe risk factors of PPCs in patients undergoing upper abdominal surgery in the South Indian population.[8] Additionally, this was the first study to compare spirometry, ASA, ARISCAT, and 6MWT in predicting PPCs.

Limitations

The limitations of the study include its relatively small sample size - some risk factors might not have reached statistical significance due to this. It was conducted in a single institute in South India. The study had no patients with ASA scores of 4 and 5 because they could not perform spirometry or 6MWT. The absence of patients in these higher ASA categories limits the generalizability of the results to individuals with more severe medical conditions. Our findings cannot be extrapolated to lower abdominal procedures or other areas because only subjects undergoing upper abdominal surgery were included.

Conclusions

In conclusion, the present study provides valuable insights into the occurrence of PPCs in patients undergoing elective upper abdominal surgery. Abnormal chest radiographs, elevated BUN levels, and prolonged duration of surgery were identified as independent risk factors for PPCs. The ASA score has a better predictive power for the development of PPCs compared to the ARISCAT score, but this is of poor clinical significance. Additionally, spirometry and the 6MWT did not show significant predictive ability. These findings can aid clinicians in preoperative risk assessment and implementing preventive measures to reduce the incidence of PPCs. Further research with larger sample sizes and consideration of additional risk factors is warranted to enhance the understanding of PPCs and their prevention.

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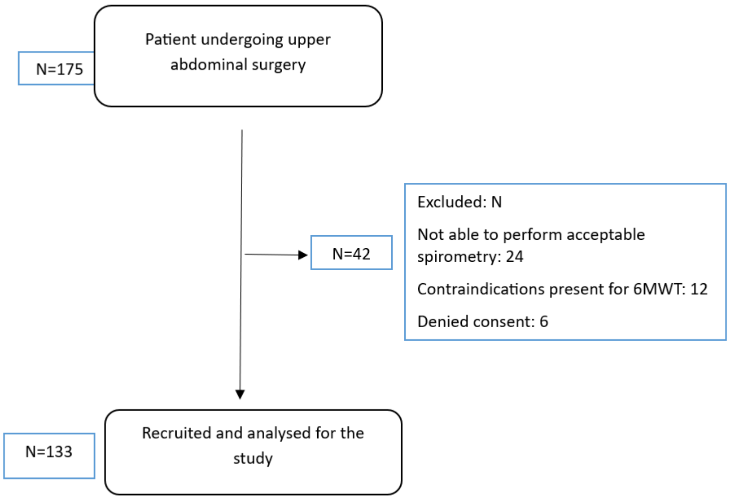

Figure 1. Consort flow diagram.

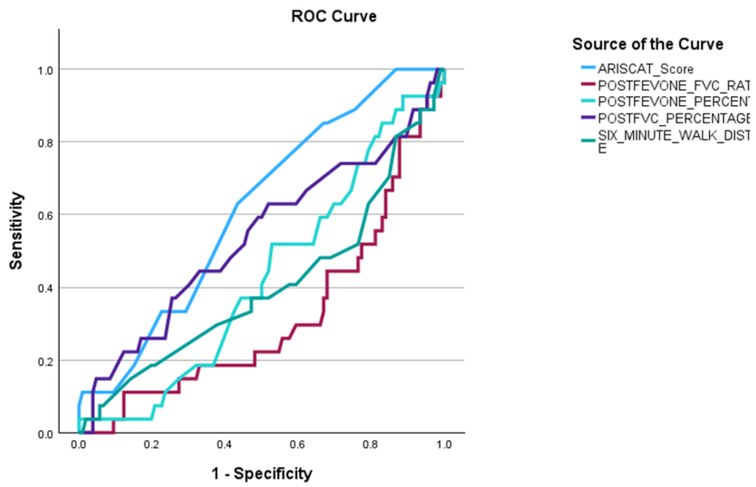

Figure 2. Receiver operating characteristic analysis to compare spirometry parameters, ARISCAT, and 6MWD in predicting PPC.

Table 1. Type of surgery undergone by the study subjects (n=133).

Surgery	Number of study subjects (%)
Cholecystectomy	17 (12.8)
Splenectomy	12 (9.0)
Pancreatectomy	23 (17.3)
Gastric surgery	30 (22.6)
Liver resection	21 (15.8)
Heapticojejunostomy	12 (9.0)
Liver transplant	3 (2.3)
Whipples/Pancreaticoduodenectomy	15 (11.3)

Table 2. Type of pulmonary complication developed in study subjects (n=133).

Pulmonary Complication	Number of study subjects (%)
Pleural Effusion	4 (3.0)
Atelectasis	1 (0.8)
Pneumonia	6 (4.5)
Aspiration Pneumonitis	2 (1.5)
Pleural Effusion, Atelectasis	3 (2.3)
Pleural Effusion, Pneumonia	1 (0.8)
Pleural Effusion, Respiratory failure	3 (2.3)
Atelectasis, Respiratory failure	2 (3)
Pneumonia, Respiratory failure	1 (3)
Pleural Effusion, Atelectasis, Respiratory failure	1 (3)
Pleural Effusion, Pneumonia, Respiratory failure	3 (3)

Table 3. Comparison of laboratory and other parameters in patients with and without pulmonary complication.

	PULMONARY COMPLICATION				Statistical significance (P value)
	No		Yes		
	Median	IQR (Q1, Q3)	Median	IQR (Q1, Q3)	
Hb (g/dL)^	11.70	9.5, 13.0	11.10	8.7, 12.4	0.071
Platelet (10^3/ml) ^	261.50	207.5, 337.0	258.0	208.0, 347.0	0.714
Albumin (g/dL) ^	3.78	3.39, 4.10	3.29	2.65, 3.96	0.030
Blood urea nitrogen (mg/dL) ^	20.0	16.0, 26.0	26.0	18.0, 32.0	0.029
Creatinine (mg/dL) ^	0.63	0.48, 0.74	0.67	0.54, 0.8	0.293
Bilirubin (mg/dL) ^	0.62	0.34, 1.20	1.16	0.44, 4.26	0.078
AST (IU/L) ^	25.50	16.75, 39.25	37.0	21, 102	0.019
ALT (IU/L) ^	20.00	12.75, 34.0	34.0	19.0, 68.0	0.009
6MWD^	370.0	320, 400	320.0	290, 400	0.127
ARISCAT Score^	38.00	33.25, 42.75	41	38, 50	0.061
Duration of surgery (hours)^	4.0	2.75, 4.0	5.0	4.0, 6.0	<0.001
Duration of hospital stay post-operatively (Days)^	6	4.0, 9.0	15	9.0, 19.0	<0.001

^Mann-Whitney test; Hb, hemoglobin; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

Table 4. Comparison of Baseline characteristics among patients with and without pulmonary complication. (N=133)

Parameter	Characteristics	PPC absent N(%)	PPC present N(%)	Total	Statistical Significance (p-value)
AGE GROUP	18-20	4 (80)	1 (20.0)		0.478
	21-30	13 (81.3)	3 (18.8)		
	31-40	21 (87.5)	3 (12.5)		
	41-50	23 (79.3)	6 (20.7)		
	51-60	21 (87.5)	3 (12.5)		
	>61	24 (68.6)	11 (31.4)		
SEX	Male	53 (76.8)	16 (23.2)		0.39
	Female	53 (82.8)	11 (17.2)		
SMOKING STATUS	Non-smoker	79 (81.4)	18 (18.6)		0.412
	Smoker	27 (75.0)	9 (25.0)		
BIOMASS FUEL EXPOSURE STATUS	Absent	74 (80.4)	18 (19.6)		0.752
	Present	32 (78)	9 (22.0)		
Diabetes Mellitus	No	75 (78.9)	20 (21.1)		0.733
	Yes	31 (81.6)	7 (18.4)		
Systemic Hypertension	No	79 (79.8)	20 (20.2)		0.961
	Yes	27 (79.4)	7 (20.6)		
Chronic kidney disease#	No	105 (79.5)	27 (20.5)		0.797
	Yes	1 (100)	0 (0.0)		
Coronary artery disease#	No	100 (80)	25 (20.0)		0.510
	Yes	6 (75)	2 (25.0)		
Obstructive airway disease#	No	103 (83.1)	21 (16.9)		0.002
	Yes	3 (33.3)	6 (66.7)		
Airflow Limitation	>0.7	89 (83.2)	18 (16.8)		0.043
	<0.7	17 (65.4)	9 (34.6)		
Significant Reversibility#	Absent	97 (81.5)	22 (18.5)		0.159
	Present	9 (64.3)	5 (35.7)		
Chest radiograph#	Normal	97 (85.1)	17 (14.9)		<0.001
	Abnormal	9 (47.4)	10 (52.6)		
Laparoscopic Surgery	No	76 (79.2)	20 (20.8)		0.806
	Yes	30 (81.8)	7 (18.9)		
Surgical Indication	Non-oncological	59 (80.8)	14 (19.2)		0.723
	Oncological	47 (78.3)	13 (21.7)		
ASA score	<3	56 (88.9)	7 (11.1)		0.012
	3	50 (71.4)	20 (28.6)		

#Fisher exact test

Table 5. Comparison of spirometry parameters in patients with and without pulmonary complication.

	PULMONARY COMPLICATION				**Statistical significance (P value)**
	No		**Yes**		
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
FEV1	71.54	17.96	68.37	19.51	0.449
FVC%	72.61	14.96	73.81	16.47	0.715
FEV1/FVC RATIO	82.64	13.32	74.31	13.45	0.006

FEV1: Forced expiratory volume in one second, FVC: Forced vital capacity

Table 6. Multivariable logistic regression analysis by forward method of covariates for PPC.

Variables	**Odds Ratio (95% CI)**	**Statistical significance (P value)**
Chest radiograph	8.26 (2.58-26.43)	<0.001
Blood Urea Nitrogen (mg/dL)	1.05 (1.00-1.09)	0.033
Duration of Surgery	1.44 (1.18-1.76)	<0.001

Table 7. Receiver operating characteristic analysis to compare spirometry parameters, ARISCAT, and 6MWD in predicting PPC.

Parameter	**AUC**	**Confidence Interval**		**Cut-off value**	**Sensitivity**	**Specificity**
		Lower limit	**Upper limit**			
ARISCAT Score	0.616	0.506	0.726	39.5	63%	57%
FVC (%)	0.538	0.407	0.669	75.5	52%	55%
FEV1 (%)	0.428	0.315	0.542			
FEV1/FVC RATIO	0.318	0.204	0.433			
6MWD (meters)	0.405	0.276	0.534			