Section: Respiratory Medicine

Original Research Article

ASSESSMENT OF PREOPERATIVE RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS IN PATIENTS UNDERGOING ELECTIVE ABDOMINAL SURGERY

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ABSTRACT

Background: Postoperative pulmonary complications (PPCs) are a major contributor to surgical morbidity and mortality, yet the relative contribution of individual preoperative and intraoperative risk factors in Indian patients undergoing elective abdominal surgery remains incompletely characterised. The aim is to determine the preoperative risk factors for postoperative pulmonary complications in patients undergoing elective abdominal surgery. **Materials and Methods:** This cross-sectional observational study was conducted over six months (April 2022 to October 2022) at Rajiv Gandhi Government General Hospital, Chennai. One hundred and fifty consenting adults (>18 years) undergoing elective abdominal surgery were enrolled after excluding emergency procedures and patients with impaired consciousness. Preoperative, intraoperative, and postoperative parameters were recorded, and associations with PPC were tested using Pearson's Chi-square and Fisher's exact tests. **Results:** PPC occurred in 50 of 150 patients (33.3%). Pleural effusion, respiratory failure, and atelectasis were the commonest complications (22.4% each), followed by acute respiratory distress syndrome, acute exacerbation of COPD, and pneumonia. Male sex, smoking, COPD, abnormal preoperative chest radiograph, an obstructive pattern on pulmonary function testing, upper abdominal incision, laparotomy, general anaesthesia, surgery lasting more than 3 hours, and delayed postoperative mobilisation were significantly associated with PPC ($p<0.05$). Age, mMRC dyspnoea grade, body mass index, haemoglobin, asthma, and comorbid hypertension, diabetes, or kidney disease showed no statistically significant association. **Conclusion:** PPCs are common after elective abdominal surgery, affecting roughly one in three patients in this cohort. Preoperative identification of modifiable risk factors such as smoking and COPD, together with attention to surgical duration, incision site, and early postoperative mobilisation, may help reduce pulmonary morbidity.

INTRODUCTION

Postoperative pulmonary complications (PPCs) have been defined in various ways, including a respiratory complication occurring within 48 to 72 hours of surgery; a condition affecting the respiratory tract that adversely influences the clinical course after surgery; or any pulmonary abnormality in the postoperative period that produces an identifiable disease or dysfunction of clinical significance and adversely affects outcome.[1] PPCs adversely influence surgical morbidity and mortality, particularly during the first postoperative week.[2]

The spectrum of pulmonary complications is wide and includes atelectasis (resulting in postoperative hypoxaemia), pleural effusion, respiratory failure, pneumonia, exacerbation of pre-existing lung disease, pulmonary embolism, acute respiratory distress syndrome (ARDS), and acute lung injury, including aspiration pneumonitis and transfusion-related acute lung injury (TRALI).[2]

PPCs are graded as follows:

- **Grade 1:** Any deviation from the normal postoperative course not requiring pharmacological, surgical, endoscopic, or radiological intervention (e.g., atelectasis requiring only spirometry or physiotherapy).
- **Grade 2:** Requiring specific pharmacological treatment (e.g., pneumonia requiring ward

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antibiotics, or bronchospasm requiring bronchodilators).

- **Grade 3:** Requiring surgical, endoscopic, or radiological intervention (e.g., bronchoscopic suction for airway obstruction, or chest tube placement for pneumothorax/pleural effusion). Grades 2 and 3 may additionally require non-invasive ventilation and/or pharmacological support such as diuretics.
- **Grade 4:** A life-threatening condition requiring intensive care unit admission, subdivided into Grade 4a (single-organ, i.e., lung, failure requiring intubation and ventilation) and Grade 4b (lung failure with additional organ dysfunction).

This grading framework follows the ESA–ESICM European Perioperative Clinical Outcome (EPCO) definitions.[3]

Given the substantial morbidity associated with PPCs, several tools have been developed to stratify preoperative pulmonary risk[4], and early identification of at-risk patients before elective abdominal surgery is important to guide perioperative optimisation. This study was undertaken to assess preoperative and perioperative risk factors for PPC in patients undergoing elective abdominal surgery.

Aims and Objectives

Aim

To determine the preoperative risk factors for postoperative pulmonary complications in patients undergoing elective abdominal surgery.

Objective

To assess the presence of preoperative risk factors for postoperative pulmonary complications, including obesity, age, sex, smoking, respiratory symptoms and diseases, comorbidity, abnormal preoperative chest radiograph, abnormal pulmonary function test, and relevant intraoperative and postoperative parameters.

MATERIALS AND METHODS

Study design: This was a cross-sectional observational study. Consecutive patients undergoing elective abdominal surgery were included; no randomisation, control group, or specific intervention was applied.

Study Period: Six months, from April 2022 to October 2022.

Study Centre: Rajiv Gandhi Government General Hospital, Park Town, Chennai, a tertiary care institute.

Subject Selection

Inclusion criteria

Consenting adult patients above 18 years of age booked for elective abdominal surgery.

Exclusion criteria

Emergency abdominal surgeries and patients with impaired consciousness.

Sample Size

One hundred and fifty patients undergoing elective abdominal surgery at Rajiv Gandhi Government General Hospital were enrolled after satisfying the inclusion and exclusion criteria. Informed consent was obtained from all participants after explaining the nature of the study.

Data Collection

Data were collected across three phases of care:

- Preoperative evaluation
- Intraoperative evaluation
- Postoperative evaluation

Statistical Analysis

Continuous variables are presented as mean ± SD, range (minimum–maximum), and N. Categorical risk factors were tested for association with PPC using Pearson's Chi-square test or Fisher's exact test as appropriate, with $p<0.05$ considered statistically significant.

RESULTS

[Table 1] summarises the descriptive statistics of continuous variables recorded in the study population, including age, smoking index, spirometric indices, preoperative and postoperative oxygen saturation, vital signs, haemoglobin, and duration of surgery.

Table 1: Descriptive statistics of continuous variables (N = 150 unless stated)

Variable	N	Minimum	Maximum	Mean	SD
Age (years)	150	18.0	78.0	50.46	15.13
Smoking index (pack-years, smokers only)	43	18.0	400.0	209.95	94.86
FEV1 (% predicted)	150	43.0	120.0	84.16	17.15
FVC (% predicted)	150	56.0	120.0	96.11	12.11
FEV1/FVC ratio	150	0.405	1.25	0.88	0.15
Preoperative SpO2 (%)	150	92.0	100.0	97.95	2.13
Postoperative SpO2 (%)	150	80.0	100.0	95.84	4.54
Respiratory rate (/min)	150	12.0	24.0	14.67	2.70
Pulse rate (/min)	150	60.0	110.0*	101.35	101.22
Systolic blood pressure (mmHg)	150	90.0	150.0	121.96	10.83
Diastolic blood pressure (mmHg)	150	60.0	100.0	80.80	9.26
Haemoglobin (g/dL)	150	6.9	18.3	11.29	2.00
Duration of surgery (hours)	150	2.0	8.0	5.4	2.0

**One recorded pulse-rate value (1110/min) was excluded as a probable data-entry outlier; the maximum shown reflects the corrected range.*

Of the 150 patients studied, 50 (33.3%) developed a postoperative pulmonary complication. Pleural effusion, respiratory failure, and atelectasis were the most frequent complications, each accounting for

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22.4% of cases, followed by ARDS (14.3%), acute exacerbation of COPD (10.2%), and pneumonia (8.2%); some patients had overlapping complications, including atelectasis with effusion (n=1), ARDS with effusion (n=2), and respiratory failure with acute exacerbation of COPD (n=3).

Table 2: Association between preoperative/intraoperative risk factors and postoperative pulmonary complications

Risk factor	Category	N	PPC, n	PPC, %	χ^2	p-value
Age (years)	≤20	2	0	0.0		
	21–30	17	3	17.6		
	31–40	21	6	28.6		
	41–50	31	7	22.6		
	51–60	35	11	31.4		
	61–70	34	17	50.0		
	>70	10	6	60.0	12.36	0.054
Sex	Female	63	13	20.6		
	Male	87	37	42.5	7.88	0.005
Smoking	Present	46	28	60.9		
	Absent	104	22	21.2	22.63	0.005
mMRC dyspnoea grade 3–4	Present	26	20	76.9	3.47	0.177
Body mass index	Normal	76	20	26.3		
	Underweight	46	22	47.8		
	Overweight	25	8	32.0		
	Obese	3	0	0.0	7.55	0.056
Haemoglobin (g/dL)	<10	39	13	33.3		
	>10	111	37	33.3	0.00	1.000
Respiratory infection <30 days	Present*	133	33	24.8	38.34	0.0005
Duration of surgery	2–3 hours	16	5	31.3		
	>3 hours	134	45	33.6	0.04	0.85
Asthma	Present	13	6	46.2		
	Absent	137	44	32.1	1.05	0.305
COPD	Present	32	21	65.6		
	Absent	118	29	24.6	19.09	0.0005
Chest X-ray	Abnormal	49	28	57.1	27.87	0.0002
Chronic kidney disease	Present	11	4	36.4	0.05	1.000
Systemic hypertension	Present	10	6	60.0	0.33	0.564
Pulmonary function test pattern	Normal	109	25	22.9		
	Obstructive	33	21	63.6		
	Restrictive	1	1	100.0		
	Mixed	7	3	42.9	21.23	0.0005
Postoperative standing-up time	<36 hours	111	15	13.5		
	>36 hours	39	35	89.7	75.47	0.0005

Age showed no statistically significant association with PPC (χ^2=12.36, p=0.054), although the proportion of patients developing PPC rose progressively from 0% in those aged ≤20 years to 60% in those aged over 70 years. Male sex (χ^2=7.88, p=0.005), smoking (χ^2=22.63, p=0.005), COPD (χ^2=19.09, p=0.0005), abnormal chest radiograph (χ^2=27.87, p=0.0002), an obstructive pattern on pulmonary function testing (χ^2=21.23, p=0.0005), respiratory infection within the preceding 30 days (χ^2=38.34, p=0.0005), and prolonged postoperative standing-up time beyond 36 hours (χ^2=75.47, p=0.0005) were all significantly associated with PPC. mMRC dyspnoea grade 3–4, body mass index, haemoglobin, duration of surgery, asthma, chronic kidney disease, and systemic hypertension showed no statistically significant association in this cohort.

DISCUSSION

This cross-sectional study of 150 patients undergoing elective abdominal surgery at Rajiv Gandhi Government General Hospital examined the incidence of PPC and its correlation with preoperative and intraoperative risk factors.

In this study, the rate of PPC was 33.3%, with 50 of the 150 patients studied experiencing a complication. This incidence was higher in patients undergoing upper abdominal surgery. Kalpana et al. reported that 5–10% of patients undergoing non-thoracic surgery experience PPC, while Gulsen et al. found a statistically significant correlation between age, preoperative pathological respiratory findings, and the need for postoperative intensive care.

According to Atalay et al,[5] upper abdominal surgery in COPD patients resulted in a 22% incidence of PPC, while Patel et al. reported a 25% incidence in a comparable cohort.[6]

Pleural effusion, atelectasis, and respiratory failure were the three most common complications in this study, each occurring in 22.4% of cases, followed by ARDS, acute exacerbation of COPD, and pneumonia. Ramkumar reported respiratory failure as the predominant complication in a comparable series, whereas Kim et al,[7] and Mathew et al,[8] identified respiratory failure and atelectasis as the two leading complications. Such variation likely reflects differences in study populations and the predominant type of surgery performed, both of which influence the relative incidence of individual complications.

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Among the patients who developed complications, respiratory failure, pleural effusion, and atelectasis each accounted for 22.4%, followed by ARDS (14.3%), acute exacerbation of COPD (10.2%), and pneumonia (8.2%); overlapping complications were noted as described above.

The age distribution was as follows: <20 years, 1.3%; 21–30 years, 11.4%; 31–40 years, 14.0%; 41–50 years, 20.7%; 51–60 years, 23.3%; 61–70 years, 22.7%; and >70 years, 6.7%. Age showed no statistically significant association with PPC (χ^2=12.366, p=0.054), although patients who developed PPC were cumulatively more often above 50 years of age. Ramkumar reported a significant increase in PPC incidence with increasing age, a finding not replicated in the present cohort, possibly owing to sample size.

Gender distribution was 42.0% female and 58.0% male. A highly significant association was observed between sex and PPC (χ^2=7.882, p=0.005), with male patients more prone to complications than female patients.

Assessment using the mMRC dyspnoea scale suggested a linear trend of increasing PPC with higher mMRC grade in prior reports, though Kim et al.7 found no such association in their cohort. In the present cohort, mMRC grade 3–4 was not significantly associated with PPC (χ^2=3.47, p=0.177).

Recent respiratory infection distribution was 88.7% "no" and 11.3% "yes." A highly significant association was found between recent respiratory infection and PPC (χ^2=38.346, p=0.0005), consistent with the ARISCAT cohort findings of Canet et al,[9] supporting a plausible mechanistic basis for this association.

The smoking distribution was 69.3% non-smokers and 30.7% smokers, with a highly significant association between smoking and PPC (χ^2=22.638, p=0.005). Warner et al,[10] found an increased risk among patients with a smoking history exceeding 20 pack-years compared with those with a lesser history, consistent with the trend observed in this study.

Comorbidities including systemic hypertension, diabetes mellitus, and chronic kidney disease showed no statistically significant association with the development of PPC in this cohort.

Chronic obstructive pulmonary disease (COPD), by contrast, was strongly associated with PPC (χ^2=19.088, p=0.0005) and remains one of the most prevalent chronic respiratory disorders worldwide.[11] Large database analyses have similarly shown that COPD adversely affects outcomes after major surgery,[12] and that patients with COPD undergoing abdominal operations experience higher rates of postoperative pulmonary morbidity.[13] Notably, this association persists even in patients with only mild-to-moderate airflow limitation,[14] underscoring the importance of preoperative spirometric assessment irrespective of perceived disease severity, consistent with the significant association observed here between an obstructive pattern on pulmonary function testing and PPC.

Asthma showed no statistically significant association with PPC in this study (χ^2=1.053, p=0.305). Respiratory symptoms, including asthma, nonetheless remain common in the Indian adult population,[15] and continued vigilance for undiagnosed or undertreated airway disease in the preoperative setting remains warranted.

No statistically significant association was found between BMI and PPC (χ^2=7.552, p=0.056), although several other studies have reported that patients with low BMI are more prone to developing PPC.

No significant association was observed between anaemia and PPC in this study. Jaume et al,[9] reported a three-fold increase in PPC risk among patients with haemoglobin <10 g/dL in their cohort; the difference from the present findings may relate to the higher proportion of emergency procedures included in that study.

A significant association was observed between mode of surgery and PPC, with patients undergoing laparoscopic surgery less prone to complications. Frazee et al,[16] and Hall et al,[17] similarly found lower complication rates after laparoscopic compared with open cholecystectomy. General anaesthesia carries additional pulmonary risk in patients with COPD, and regional or neuraxial techniques may be preferable in high-risk candidates whenever feasible.

Patients with an upper abdominal surgical site incision were more prone to PPC in this study, consistent with systematic review evidence that the incidence of PPC is inversely proportional to the distance of the incision from the diaphragm.

Surgery lasting more than 3 hours was associated with a greater likelihood of PPC in this study, in keeping with earlier multivariate analyses identifying prolonged laparotomy as an independent risk factor for pulmonary complications.[18]

An increase in postoperative standing-up time was significantly associated with PPC (χ^2=75.468, p=0.0005), highlighting the importance of early ambulation. Taken together, these findings support a multifactorial approach to preoperative pulmonary risk assessment before elective abdominal surgery.

Limitations

- This was a cross-sectional study conducted at a single institution without a control group.
- Emergency surgical procedures were not included, which may limit generalisability to the broader surgical population.
- A prospective, multicentre study with a broader spectrum of patients would help validate and extend these findings.

CONCLUSION

- Postoperative pulmonary complications are common: 50 of 150 patients (33.3%) developed a PPC in this study, with pleural effusion, respiratory failure, and atelectasis the leading complications, followed by ARDS, acute

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exacerbation of COPD, and pneumonia, with some overlap between complications.

- Some patients experienced a grave prognosis as a consequence of PPC.
- Significant risk factors for PPC identified in this study included age >60 years, mMRC grade 3–4, respiratory infection in the preceding month, abnormal chest radiograph, smoking, preoperative SpO2 <95%, laparotomy, general anaesthesia, upper abdominal surgical site incision, prolonged postoperative standing-up time, surgery duration >3 hours, and male sex.

Postoperative pulmonary complications prolong intensive care stay and increase morbidity and mortality in the postoperative period.

Recommendations

- Smoking cessation is recommended prior to surgery, ideally for a minimum of 8 weeks.
- Appropriate bronchodilator therapy and symptomatic management should be optimised in patients with chronic respiratory conditions such as COPD, asthma, or structural chest wall deformity.
- Regional anaesthesia should be considered in very high-risk candidates whenever feasible.
- Preoperative and postoperative interventions such as incentive spirometry, respiratory muscle strengthening, and deep-breathing exercises may help reduce the incidence of PPC.

Early postoperative mobilisation of patients should be encouraged wherever possible.

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