Incidence of Post-Operative Pulmonary Complications in Patients Undergoing Emergency Laparotomy under General Anesthesia

Annam Qayoom[1], Baby Shanaz Geelani[2], Yasir Iqbal Lone[3], Muhiba Shabir[1] and Sana Khan[1*]

[1]Postgraduate Scholar, Department of Anaesthesiology and Critical Care, Pain and Palliative Medicine, Government Medical Collage, Srinagar, India

[2] Associate professor, Department of Anaesthesiology and Critical Care, Pain and Palliative Medicine, Government Medical Collage, Srinagar, India

[3]Senior Resident, Department of Urology, Government Medical College Srinagar, India

Corresponding Author*

Sana Khan

Postgraduate Scholar, Department of Anaesthesiology and Critical Care, Pain and Palliative Medicine, Government Medical Collage, Srinagar, India. E-mail: sanaihsan7@gmail.com

Received: 19-July-2023, Manuscript No. mrcs-23-107357; **Editor assigned:** 21-July-2023, Pre QC No. mrcs-23-107357(PQ); **Reviewed:** 26-July-2023, QC No. mrcs-23-107357(Q); **Revised:** 03-August-2023, Manuscript No. mrcs-23-107357(R); **Published:** 09-August-2023, DOI: 10.37532/mrcs.23.8.5.001-005

Abstract

Background: Postoperative pulmonary complications are an important factor responsible for mortality and morbidity. It's one of the significant complications following surgery. It includes a spectrum of clinical conditions that account for a substantial proportion of risk related to anaesthesia and surgery.

Aim & Objectives: To evaluate the incidence of postoperative pulmonary complications and factors responsible for the development of post-operative pulmonary complications in patients undergoing emergency laparotomies under general anaesthesia in our setup.

Methods: Prospective observational study conducted in the Postgraduate Department of Anaesthesiology and Critical Care Medicine, Government Medical College Srinagar. The study was conducted over a period of 18 months from 2020 to 2022. After obtaining approval from the ethical committee and written informed consent, 1063 patients greater than 21 years of age undergoing emergency laparotomies under general anesthesia were included. Post-Operative Pulmonary Complications (POPCs) were identified based on routine clinical diagnosis as per EPCO definitions, fall in SPO2 <94%, RR>20, any abnormality in CXR, any added sound on auscultation, raised temperature and any derangement in ABGs. Length of hospital stay was also noted for all the patients.

Results: Out of 1063 subjects recruited that underwent emergency abdominal surgeries, 250 developed POPCS. A significant cumulative association of surgical diagnosis with post-surgical complications, albeit the prevalence of post-surgical complications varied in various surgical diagnosis. We did not observe any significant difference in the prevalence of post-surgical complications when the subjects were classified based on the presence or absence of pre-operative pulmonary complications. A positive correlation between the duration of surgery and the prevalence of surgical complications. ($p<0.001$) was observed among the study population.

Conclusion: In the present study, given a reasonably large sample size, we were able to identify certain risk factors of POPC in our population, however more replicative studies with a larger sample size are warranted to substantiate these findings so that future preventive strategies can be formulated for preventing POPCs in patients undergoing laparotomies.

Keywords: Post-operative pulmonary complications • Laparotomy • Risk factors • Mortality • Morbidity • General Anaesthesia

Introduction

Postoperative pulmonary complications cause a consequential increase in postoperative morbidity, mortality and increase in the duration of hospital stay and hence a significant increase in healthcare costs [1-6]. Although POPC are recognised to be common but the reported incidence is variable ranging from 2-40% [7].

The incidence of POPC depends on the type and nature of the surgery, for example the incidence of pneumonia is higher after abdominal surgery as compared to urological or spinal surgeries [8]. There is 15 times more risk of developing POPC when an upper abdominal incision is given as compared to lower abdominal incision [9]. Although the type of surgery is a non-modifiable risk factor. Laparoscopic surgery for both upper and lower gastrointestinal procedure results in fewer POPC as compared with open procedures [10].

Preoperative spirometry and arterial blood gases have been cited useful in predicting the incidence of POPC. However, the National Institute for Health and Care Excellence (NICE) advises that the use of spirometry and ABGs should only be performed at the exclusive request of a senior anaesthetist for ASA score III or IV patient with confirmed or suspected respiratory disease. Likewise, the usefulness of preoperative Chest X ray had inconsistent results and should not be offered routinely before elective surgeries [11]. However, in recent studies, low preoperative O2 saturation was found to be a significant independent risk factor for postoperative pulmonary complication prediction model. Comparison was done between patients with preoperative SpO2 ≥96%, 91%- 95% and <90% and it was found that patients with low saturation were 10 times more prone to develop postoperative pulmonary complications [12].

There is wide variability in the incidence of postoperative pulmonary complications for different types of elective surgical procedures as observed in different studies ranging from 9%-40%. These elective surgeries included abdominal, cardiac or other non-thoracic surgeries, when there is enough time for the management of the risk factors for postoperative pulmonary complications in these elective surgeries. However, emergency surgeries don't allow the luxury of preoperative management of the risk factors for postoperative pulmonary complications. Hence, a similar study in emergency patients is needed to calculate the incidence of postoperative pulmonary complications in patients undergoing emergency abdominal procedures. The demographic and clinical characteristics of patients as well as preoperative diagnosis and surgical strategies are expected to be quite diverse in emergency surgeries than those of elective procedures and therefore, emergency procedures carry higher mortality and morbidity.

Material and Methods

The present study was conducted in the Postgraduate Department of Anaesthesiology and Critical Care Medicine, Government Medical College Srinagar.

Study design

Prospective observational study : The study was conducted over a period of 18 months from 2020 to 2022. After obtaining approval from the ethical committee and written informed consent, 1063 patients greater than 21 years of age undergoing emergency laparotomies under general anesthesia were included.

Inclusion criteria

1. Adult patients of 21-65 years.
2. Patients undergoing emergency laparotomies under GA.
3. ASA I, II.

Exclusion criteria

1. Patients with uncontrolled pulmonary disease existing prior to surgical procedure (e.g., COPD, ILD)
2. ASA III, IV.
3. Patients not willing to enroll themselves in this study.
4. All patients received routine pre-operative, intraoperative and post-operative care. All patients who were recruited for the study were followed up by daily basis to the respective wards for a period of 5 days. A structured questionnaire on patient, anaesthesia and surgical factors were filled during this period by the investigator.

Routine pre-operative assessment was conducted and data regarding age, sex, American Society of Anaesthesiologists (ASA) physical status, any pre-existing co morbidity, smoking history, respiratory infection in last 1month, pre-operative Oxygen Saturation (SPO2) on room air was collected. A thorough evaluation of the respiratory system was undertaken for all the patients. Data recorded on the surgical procedure included type of surgery, duration of surgery and any intra-operative respiratory complication. Post-operative presence of nasogastric tube was also noted.

Post-Operative Pulmonary Complications (POPCs) were identified based on routine clinical diagnosis as per EPCO definitions [7], fall in SPO2 <94%, RR>20, any abnormality in CXR, any added sound on auscultation, raised temperature and any derangement in ABGs. Length of hospital stay was also noted for all the patients. Data was then tabulated in an excel sheet.

Statistical Analysis

Analysis was performed using SPSS software for Windows (version 25, 2007, IBM Corporation, Armonk, New York, United States). Data presented as frequency (%). Cross tabulations were computed and compared using the chi-square test. $p<0.05$ was considered to be significant.

Results

We recruited 1063 patients in our study that underwent laparotomy over one and a half years. Demographic profile of the study population in depicted in the Table 1.

Table 1. Demographic profile of the study population.

Age (years)	34.6±9.7
Male/Female	37.3/62.7
ASAI/II	41.1/58.6
Smokers/Non-smokers	13.4/86.6

The most common surgical diagnosis was intestinal obstruction followed by appendicular perforation. The least common surgical diagnosis in our subjects was a rupture haemorrhagic cyst (Table 2).

Table 2. Surgical diagnosis among the study population.

Variables	Frequency (n=1063)	Percentage
Appendicular perforation	196	18.4
Duodenal perforation	150	14.1
Gastric perforation	158	14.9
Ileal perforation	9	0.8
Ileocecal lump	125	11.8
Intestinal obstruction	228	21.4
Large ventral hernia	55	5.2
Rectal perforation	41	3.9
Ruptured ectopic pregnancy	26	2.4
Ruptured haemorrhagic cyst	14	1.3
Ruptured liver abscess	8	0.8
Stab injury abdomen	15	1.4
Torsion ovaries	38	3.6

Out of 1063 patients, 868 (81.6%) had no pre-operative pulmonary complications. 87 (8.2%) suffered from COPD< 62 (5.8%) suffered from bronchial asthma, 21 (2%) suffered from pulmonary tuberculosis and 25 (2.4%) suffered from bronchiectasis (Table 3).

Table 3. Pre-operative pulmonary complications

Variables	Frequency (n=1063)	Percentage
COPD	87	8.2
Bronchial asthma	62	5.8
Pulmonary tuberculosis	21	2
Bronchiectasis	25	2.4
None	868	81.6

The most common post-operative pulmonary complication was atelectasis found in 76 (7.1%) cases, and acute exacerbation of COPD 71 (6.7%)]. The least common post-operative pulmonary complication was pulmonary oedema [2 (0.2%)]. Overall 250 (23.5%) patients suffered from post-operative pulmonary complications (Table 4).

Table 4. Post-operative pulmonary complications.

Variables	Frequency (n=1063)	Percentage
Atelectasis	76	7.1
Pneumonia	31	2.9
Aspiration pneumonitis	27	2.5
Broncho spasm	18	1.7
Respiratory failure	18	1.7
Pleural effusion	14	1.3
Acute exercabation of COPD	71	6.7
Pulmonary oedema	2	0.2
Total post-surgical complications	250	23.5

There was a significant difference in prevalence of post-surgical complication when classified according to age ($p<0.05$). Higher percentage of patients aged >41 years had post-operative pulmonary complications as compared to youngers patients (Figure 1).

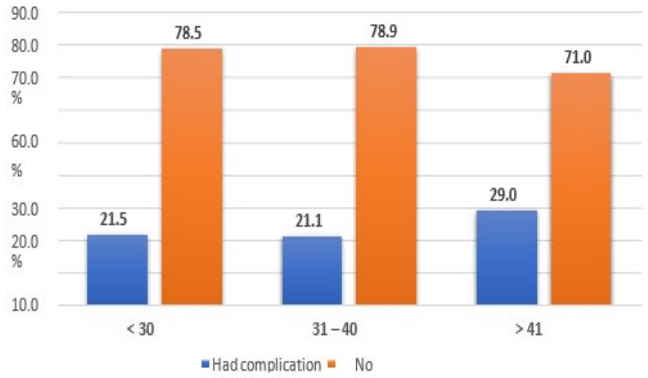

Figure 1. Pulmonary complications as compared to youngers patients.

Significantly higher percentage of males had post-surgical complications as compared to females (p<0.05) (Figure 2).

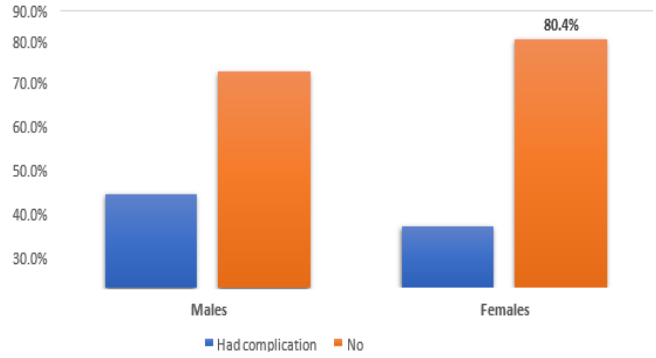

Figure 2. Males and females post-surgical complications.

Significantly higher percentage of smokers had post-operative pulmonary complications as compared to non-smokers (p<0.05) (Figure 3).

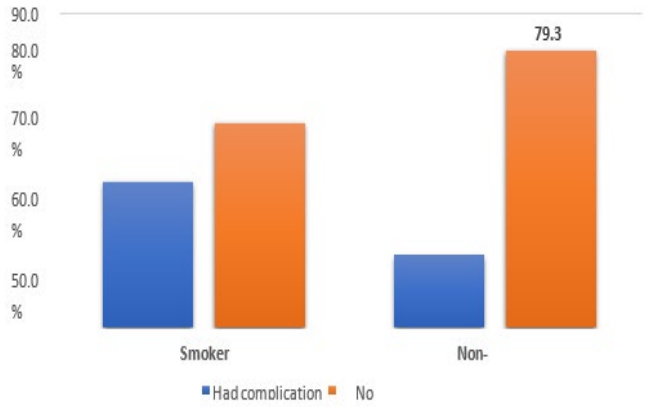

Figure 3. Smokers and non-smokers post-operative pulmonary complications.

Prevalence of post-operative pulmonary complications increased with an increase in duration of surgery and this difference was significant (p<0.05) (Figure 4).

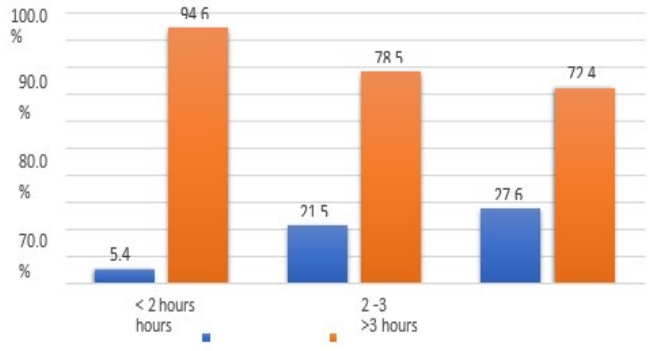

Figure 4. Prevalence of post-operative pulmonary complications.

Discussion

Globally, the annual surgical procedures performed continue to rise with more than 14 million admissions for surgical procedures reported in 2006 in the United States alone [13]. Many patients undergoing surgical procedures, experience Postoperative Pulmonary Complications (POPC) with rates as high as 30% in some patient groups [14]. POPCs are an important factor responsible for post-op morbidity and mortality. Moreover, POPCs are accountable for patient suffering, prolonged hospital stay, and increased healthcare costs. In the current study, we investigated the incidence and associated risk factors of postoperative pulmonary complications in patients undergoing emergency laparotomies under general anaesthesia at a tertiary care hospital in Kashmir.

We found a positive correlation between post-laparotomy POPCs with the increased age of the patients. Elderly patients have a higher risk for the number and severity of medical co-morbidities that are likely to add to the complexity of both surgery and anaesthesia. Moreover, aged patients may take considerably longer to recuperate postoperatively although recent studies and scoring systems show that this is very subjective and that many older patients recover well postoperatively and return to function as well as their peers [15-18]. Given this observation, the elevated risk of elderly patients developing POPC, post-laparotomy is not an uncommon observation in our study. Although statistically significant, we found marginal increment in the POPC cases as we move along the age axis. Unlike ours, earlier studies have shown the risk of a postoperative pulmonary complication is twice as high in patients' age 60 to 69 years and there is a 3 fold increase in patients aged 70–79 years when compared to patients less than 60 years [19]. The differences might be attributed to difference in sample sizes of these studies.

Of all the subjects enrolled in the study, women showed a significant overrepresentation and made up ~67% of the participants when compared to males (37%). However, we observed that males (30%), who underwent laparotomies had a greater incidence of POPC than females (~20%), and the frequency varied significantly by gender. Our results are in line with the global literature wherein males have shown predominance in post-op POPCs. Earlier studies including some from India [20] and one from Kashmir [21] have reported the male-to-female ratios as high as 3.2:1 [22-25].

Of all the cases recruited in our study who underwent laparotomy, a sizable portion had ASA grade II, and after stratification, we did not find significant differences in the prevalence of post-operative pulmonary complications when the subjects were classified according to ASA grade. It has been reported that high ASA class predicts increased mortality at 12 months after emergency laparotomy. Moreover, in a single-centre study of patients over 70 years of age were found that low ASA scores may predict an increased likelihood of survival and described a correlation between preoperative lactate and haemoglobin and days to death [26]. Unlike our results, Tennant et al, in their study, found more patients in ASA grade I patients who underwent surgeries and developed POPCS [27]. It is tempting to speculate that these differences can be attributed to differences in the study design and sample size and warrants further substantiation in replicative studies.

In the current study, out of 1063 subjects enrolled, a total of 250 (23.5%) patients suffered from post-operative pulmonary complications. Unlike pulmonary oedema, the most common post-operative pulmonary complications were atelectasis (30%) and acute exacerbation of COPD (28%). Similar to our results, Serejo et al in their study found that ~21% of subjects developed post-op atelectasis after emergency abdominal surgery [28]. Atelectasis is induced intraoperatively due to various factors such as induction of general anaesthesia with the effect of general anaesthetics, Neuromuscular (N-M) blocker-induced muscle paralysis, recumbent position, increased intra-abdominal pressure (like in laparoscopies), various operative positions such as Trendelenburg's position. The most affected part of the lungs is the basal segment. In one study, in patients with normal lungs, 90% developed atelectasis in the most dependent segments after intubation [29,30]. The atelectasis can exceed 15–20%. The degree of atelectasis can be even more in obese patients. In the case of abdominal surgeries, the atelectasis can persist for several weeks postoperatively. In an earlier study, Schlenker, and Hubay found that the incidence of atelectasis was related to the duration of surgery but not to age or obesity. No correlation was found between the bacteriologic state of the lower respiratory tract at the time of surgery. Based on this study, atelectasis is shown not to be related to an infectious process [31]. However, in the current study, we did not account for the correlation between atelectasis, BMI, or duration of surgery.

To date, studies evaluating the effects of preoperative smoking on postoperative pulmonary complications have focused on surgical patients undergoing laparotomy. There is limited information available regarding pulmonary complications in surgical patients undergoing abdominal laparoscopic procedures [32]. Moreover, smoking is a known risk factor for postoperative pulmonary complications. POPCs following abdominal surgery are frequent and associated with increased morbidity and mortality and length of hospital stay [33]. In the current study, we found ~13% of subjects who underwent laparotomy were smokers. However, we found a ~3-fold risk (OR: 2.7; 95%CI: 1.9 – 3.9) of developing POPC among the subjects who underwent laparotomy. Similar to our results, a recent large retrospective cohort analysis based on 800 Korean patients found significant associations between smoking status and postoperative complications [34].

However, Kanat et al did not find any correlation between smoking and POPC in subjects who underwent laparotomy [35]. In patients undergoing a variety of non-neurosurgical operations, smoking has been identified as an independent risk factor for poor operative outcomes. Smoking is a known risk factor for the formation of the intracranial aneurysm [36], subarachnoid hemorrhage (SAH) [37-39], and symptomatic vasospasm [40]. Even if smoking itself does not exert an independent effect on postoperative outcomes, one might expect its associated comorbidities to influence the morbidity or mortality levels after major operations such as cranial surgery [41]. Given these observations, if the association of smoking with POPCs is causal, more replicate and mechanics studies are warranted to substantiate our findings.

Unlike rupture and hemorrhagic cysts, in the current study, we found that the most common surgical diagnosis was intestinal obstruction followed by appendicular perforation. Similar to our results Bansal et al also found intestinal obstruction in ~25% of subjects, however, unlike our results, perforation peritonitis was their common surgical diagnosis [42]. We observed a significant cumulative association of surgical diagnosis with post-surgical complications, albeit the prevalence of post-surgical complications varied in various surgical diagnoses.

Out of 1063 patients enrolled in our study, ~8% were found to have Chronic obstructive pulmonary disease (COPD), ~6% had bronchial asthma, and ~2% had pulmonary tuberculosis or bronchiectasis each. We did not observe any significant difference in the prevalence of post-operative pulmonary complications when the subjects were classified based on the presence or absence of pre-operative pulmonary complications. However, when the subjects were further stratified, unlike bronchial asthma, pulmonary tuberculosis, and bronchiectasis, we found >35-fold (OR: 35.7, 95%CI: 18.3 – 73.2) risk of developing POPC in patients who underwent laparotomy and had COPD. COPD affects a large section of the whole population and is also one of the risk factors for POPCs in the perioperative setting [43]. Impaired pulmonary function, which is a remarkable manifestation of COPD, is also one of the risk factors of POPCs [44-45]. Findings from Chinese populations have reported that COPD affected 13.7% of people over 40 years of age and results in a hospital stay rate of 1.6% in 2015 [46-47]. Studies have also confirmed that the introduction of COPD treatment can reduce the risk of PPCs [45]. On the other hand, PPCs and their treatment can alter the disease course significantly in COPD patients [48].

We found a positive correlation between the duration of surgery and the prevalence of post- operative pulmonary complications ($p<0.001$). In recent decades, a growing body of evidence has suggested that surgical or operative duration is an independent and potentially modifiable risk factor for post-operative pulmonary complications. A systematic review by Visser et al, identified, categorized, and ranked various patient- and surgery-related risk factors for POPCs; prolonged operative duration was among the top three surgery-related factors [49]. The findings of a recent meta-analysis also demonstrated a robust association between prolonged operative time and POPCs across surgical specialties. The meta-analysis of a subset of these studies demonstrated that the likelihood of complications approximately doubled with prolonged operative duration [50]. The exact mechanisms underlying the positive association between pulmonary complications and prolonged operative durations are not fully understood and are likely to vary for different types of complications. Prolonged operative duration can be attributable to various time-related factors such as prolonged microbial exposure, diminished efficacy of antimicrobial prophylaxis over time, increased tissue retraction leading to tissue ischemia, necrosis, and desiccation, and increased opportunities for violations in sterile technique [51-55].

Conclusion

In the present study, given a reasonably large sample size, we were able to identify certain risk factors of POPC in our population; however more replicative studies with a larger sample size are warranted to substantiate these findings so that future preventive strategies can be formulated for preventing POPCs in patients undergoing laparotomies.

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Cite this article: Qayoom. A., et al., Incidence of Post-Operative Pulmonary Complications in Patients Undergoing Emergency Laparotomy under General Anesthesia . Med. Rep. Case Stud. 6(1), 2023. 001-006.