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Post-operative Pulmonary Complications following Laparotomy for Acute Abdomen: An Observational Study at a Tertiary Care Institute in Tripura

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ABSTRACT

Background: Post-operative pulmonary complication (PPC) encompasses almost any complication affecting the respiratory system after anaesthesia and surgery. It constitutes a remarkable amount of morbidity and mortality related to surgery and anaesthesia and may lead to longer stay in the hospital. Therefore, present study was designed to investigate pulmonary complications in patients undergoing laparotomy for acute abdomen, estimate the proportion of complications, and evaluate post-operative outcomes.

Methods: This observational study involved assessing patients admitted for acute abdominal conditions requiring laparotomy, preparing them for surgery, monitoring postoperative complications through clinical and radiological assessments, obtaining ethical approval and informed consent, and performing statistical analysis on the collected data.

Results: In our study, patients above 50 years are mostly developing PPC with male preponderance. The patients, who underwent laparotomy for peptic perforation developed PPC mostly. Correlation was observed in patients with co-morbidities. A significance of 0.02 was noted for BMI. The patients, who developed pulmonary complications had more days of ICU stay. Atelectasis was the most common complication (40%) followed by respiratory tract infections (35%). The death rate in our study was 4%, out of which 75% was due to pulmonary complications.

Conclusion- The study found a 20% incidence of post-operative complications in laparotomy patients, with males and those with comorbidities at higher risk. PPC was associated with increased morbidity and mortality rates, emphasizing the need for preventive measures and further research on PPC strategies.

Key-words: Acute abdomen, Atelectasis, Laparotomy, Post-operative pulmonary complications

INTRODUCTION

Post-operative pulmonary complication (PPC) encompasses almost any complication affecting the respiratory system after anaesthesia and surgery. PPC constitutes a huge amount of morbidity and mortality related to surgery and anaesthesia and may lead to longer stays in the hospital [1].

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PPCs were defined by the occurrence of one or more of the following during the first postoperative week: respiratory infection (pneumonia and acute bronchitis), major atelectasis (one or more pulmonary segments), exacerbation of pre-existing lung disease, respiratory failure due to primary pulmonary disorders (extrapulmonary sepsis with acute respiratory distress syndrome, cardiogenic pulmonary oedema, and other non-pulmonary conditions were excluded), and pulmonary embolism [2].

PPC following laparotomy for acute abdomen includes atelectasis, pneumonia, respiratory failure, and acute exacerbations of pulmonary diseases [3,4]. These complications are primarily influenced by factors such as

the length of the incision made during surgery and the time between patient mobilization and extubation [4]. Compared to other types of surgery, emergency laparotomy poses a higher risk for PPCs due to the nature of the procedure and the underlying conditions of patients. Additionally, emergency laparotomy patients are at a higher risk of developing respiratory infections, atelectasis, and chest infections due to restricted breathing patterns post-surgery [5]. Implementing protective lung ventilation strategies, such as low tidal volume ventilation and positive end-expiratory pressure, can help reduce the incidence of PPCs in patients undergoing laparoscopic surgery, ultimately improving postoperative outcomes [6].

The incidence of PPC varies based on patient factors such as age, sex, and comorbidities. Older adults are at a significantly increased risk for PPCs, with a correlation between PPCs and advanced age, cognitive impairment, and functional dependence [7]. Additionally, males tend to have a higher incidence of pulmonary complications after surgical resection of lung cancer compared to females, with men experiencing more total complications and higher mortality rates post-surgery [8]. Factors like resting pressure of end-tidal carbon dioxide ($PETCO_2$) and ventilatory efficiency ($V'E/V'CO_2$ slope) play a role in predicting PPCs in patients undergoing lung resection, with thoracotomy being strongly associated with PPC development [9]. In elderly patients undergoing elective colorectal surgery, age, preoperative red blood cell distribution width (RDW), and systemic inflammatory index (SII) were identified as independent risk factors for PPC occurrence, highlighting the importance of preoperative inflammatory status in predicting complications [10].

Effective strategies for preventing and managing PPC following laparotomy for acute cases include implementing protective lung ventilation techniques such as low tidal volume ventilation and positive end-expiratory pressure (PEEP) [11,12], perioperative respiratory physiotherapy [13], and early post-operative physiotherapy to avert complications and aid in recovery [5]. Additionally, identifying patients at risk for respiratory complications, risk stratification, and perioperative optimization are crucial steps in reducing postoperative pulmonary complications [13]. Smoking cessation, correction of anemia, and multidisciplinary involvement during different stages of surgery have also been shown to be beneficial in preventing postoperative pulmonary complications [13]. These strategies collectively aim to decrease the incidence of postoperative pulmonary complications, improve patient outcomes, and reduce healthcare costs associated with managing these complications.

There are many studies regarding post-operative complications but no sufficient studies are available regarding pulmonary complications especially in the setting of North East India, hence this study was undertaken to generate information regarding PPC in North-Eastern patients particularly patients of Tripura, and by this study the complications can be prevented or treated early.

MATERIALS AND METHODS

This observational cross-sectional study was conducted in the Department of General Surgery, AGMC & GBPH, from December 2022 to April 2024. The study population consisted of all patients who were admitted for laparotomy due to an acute abdomen during the study period.

Inclusion criteria- Patients who have undergone laparotomy for acute abdomen in AGMC were included in the study.

Exclusion criteria- Patients with chest trauma in traumatic causes of acute abdomen were excluded from the study.

Methodology- The initial assessment of patients admitted to the Department of General Surgery for acute abdominal conditions requiring laparotomy and fulfilling inclusion and exclusion criteria involves a comprehensive clinical examination, blood investigations, and radiological investigation. After the initial assessment, patients who require laparotomy are prepared for surgery. Postoperative complications may develop after laparotomy. The assessment of postoperative complications involves clinical assessment and radiological. Clinical assessment includes auscultatory findings and SpO_2 level measurement. Radiological investigations include chest X-ray and CT scan of the abdomen. The follow-up of postoperative complications involves regular clinical assessment and radiological investigations to monitor the patient's progress and ensure timely intervention if necessary.

Statistical analysis- Data was expressed in frequency and percentage. The chi-square test was used to observe inferential statistics. The $p<0.05$ was considered statistically significant.

Ethical approval- The research protocol was submitted for approval to the institutional ethical committee of AGMC. Upon receiving approval from the ethical committee of AGMC and GBPH, the study was initiated. Before participating in the study, informed consent was obtained from eligible candidates.

RESULTS

In the present study, which included 100 patients, the development of PPC following laparotomy in the acute abdomen was observed. 86% of patients were males and 14% of patients were females. Of these, most of the population falls within the age ranges of 11 to 30 years and 31 to 50 years, each with 33 individuals. The next largest group is 51 to 70 years range, with 22 individuals. The smallest groups are those under 10 years and those over 71 years, each with only 4 individuals. This suggests that the population is predominantly middle-aged, with fewer individuals in the youngest and oldest ages. The distribution of PPC based on different age groups showed that 20 patients developed PPC, while 80 patients did not develop PPC. Furthermore, 14% of the patients had diabetes mellitus and 3% of the patients had both diabetes and hypertension. Additionally, 64% of the patients belonged to the normal category of BMI, while a significant portion (21.0%) were underweight. A smaller percentage of individuals are pre-obese (13.0%) or obese (2.0%). The p-value is 0.02, which is significant (Fig. 1).

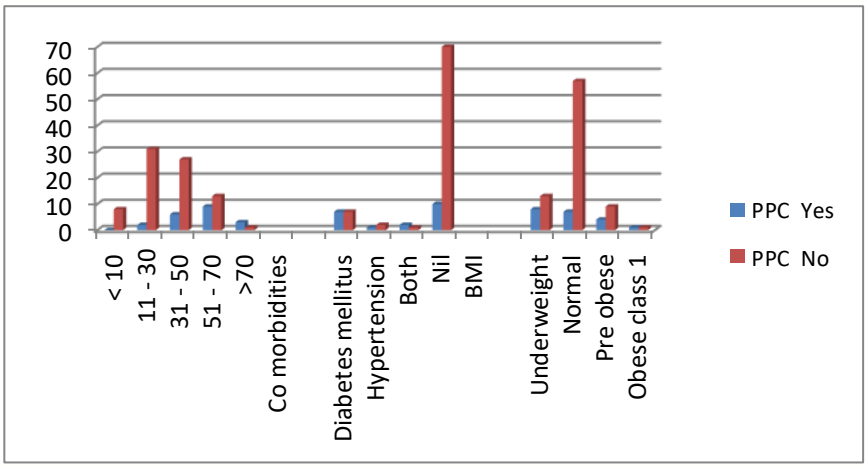


Fig. 1: Correlation of age, co-morbidities, and BMI with PPC.

The most common cause of acute abdomen who underwent laparotomy in our study was peptic perforation seen in 35%, followed by acute appendicitis in 20%. Other diagnoses, such as traumatic jejunal perforation, strangulated Richter hernia, and splenic laceration, are much less frequent, with most having only 1 or 2 cases each. This indicates a significant prevalence of peptic perforation compared to other conditions listed. PPC was frequently associated with surgery for peptic perforation. The p-value is <0.001, which is significant (Fig. 2).

Fig. 3 presents data on the correlation between the type of anaesthesia, duration of surgery and AICU stay with PPC. It shows that out of 100 cases, 54 involved general anaesthesia, 45 involved spinal anaesthesia, and 1 case involved spinal anaesthesia converted to general anaesthesia. Among those who received general anaesthesia, 13 experienced PPC, while 41 did not. For spinal anaesthesia, 6 experienced PPC, and 39 did not. The single case of spinal conversion to general anaesthesia did not result in PPC. Overall, 20 patients experienced PPC, whereas 80 did not. The majority of surgeries lasting <1 hour did not result in PPC (0 out of 26). For surgeries lasting 1 to 2 hours, 11 out of 57 cases experienced PPC. In the 2 to 3 hours category, 7 out of 15 cases had PPC, while in surgeries exceeding 3 hours, 2 out of 2 cases resulted in PPC. Overall, PPC occurred in 20 out of 100 surgeries, indicating a higher likelihood of

PPC with increased surgery duration. Furthermore, out of 100 total cases, 32 had an AICU stay, and 68 did not. Among those with an AICU stay, 15 had PPC and 17 did not. Among those without an AICU stay, 5 had PPC and 63 did not. There were significant differences observed among all the parameters ($p<0.05$).

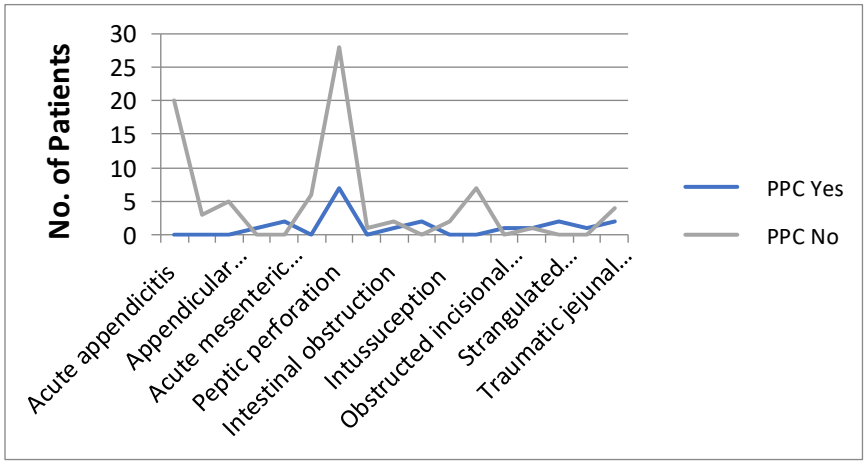


Fig. 2: Correlation of diagnosis and PPC.

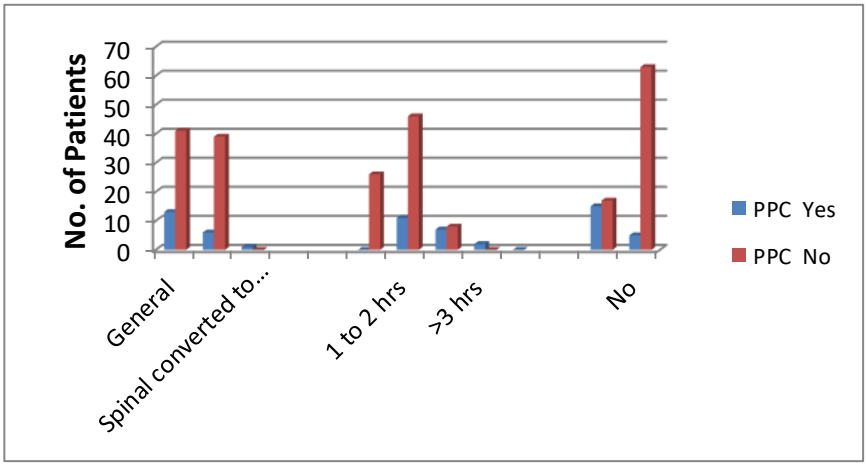


Fig. 3: Correlation of anaesthesia type, duration of surgery and AICU stay with PPC.

In the present study, 4 deaths occurred, with 3 attributed to PPC. The most prevalent type of PPC observed was atelectasis, accounting for 40% of cases. Respiratory tract infections (RTI) followed closely, representing 35% of PPC cases. The study further categorized PPC severity using the Dindo-Clavien grading system. A significant majority (85%) of patients experienced grade II PPC, which required conservative management, including antibiotic therapy. A smaller proportion (15%) of patients presented with grade IV PPC, characterized by respiratory failure necessitating invasive mechanical ventilation (Table 1 and 2).

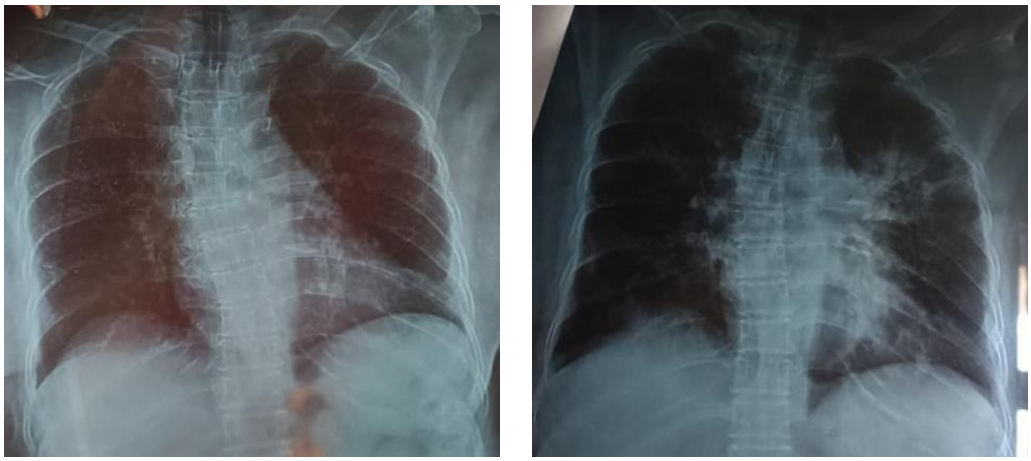
Table 1: Distribution of type of PPC.

PPC	Frequency	Percentage (%)
Atelectasis	8 (40)	40
Respiratory tract infections	7 (35)	35
Aspiration pneumonitis	1	5
Pneumonia	1	5
Respiratory failure	3	15

Table 2: Distribution of grading of PPC.

Grade	Frequency	Percentage (%)
I	0	0
II	17	85
III	0	0
IV	3	15
Total	20	100

The present study also compares pre-operative and post-operative chest X-rays of a patient. Fig. 4a depicts a normal chest X-ray taken before the operation, showing clear lung fields without any apparent abnormalities. In contrast, Fig. 4b illustrates the post-operative chest X-ray of the same patient. The post-operative X-ray reveals significant changes, including areas of increased opacity which may indicate fluid accumulation, consolidation, or other post-surgical complications. These images are crucial for evaluating the patient's respiratory status and the effectiveness of the surgical intervention.



(A) **(b)**

Fig. 4: (a) Pre-operative normal chest X-ray; (b) Post-operative chest X-ray of the same patient showing pneumonia patches.

DISCUSSION

Post-operative pulmonary complications following laparotomy for acute abdomen are significant concerns due to their association with increased morbidity and mortality. Emergency laparotomy, a common procedure for acute abdominal conditions, poses a high risk for PPCs, with factors like incision length and delayed mobilization contributing to their development [3,4]. Protective lung ventilation strategies have been shown to reduce the incidence of PPCs in patients undergoing laparoscopic surgery, emphasizing the importance of appropriate ventilation techniques in mitigating postoperative respiratory issues [6]. Additionally, the type of infusion therapy post-surgery can impact the development of interstitial edema and subsequent PPCs, highlighting the role of fluid management in preventing pulmonary complications in patients with moderate to high surgical risk undergoing urgent laparotomies [14]. Early post-operative physiotherapy is crucial in averting PPCs and aiding in the recovery of patients following emergency laparotomy [5].

PPC is observed to be more prevalent in certain age groups. In the present study, the patients included were between the age group of 7 months and 80 years, with a mean age of 37 years. Notably, out of 20 PPC patients, 9 (45%) were in the 51 to 70 years age group, with a mean age of 53.3 years. Serejo *et al*. [8] observed a PPC prevalence of 47% in patients over 50 years old, having studied 226 laparotomies. Similarly, Smith *et al.* [2] found that the mean age for developing PPC was 63.7 years in their study of 359 laparotomies.

According to the study, there is a noticeable difference in the prevalence of PPC between males and females. Our study's sample consisted of 86 (86%) males and 14 (14%) females. Of these, 14 (70%) males and 6 (30%) females developed PPC. This suggests that males are more likely to develop PPC than their female counterparts. To further validate this finding, we can compare it with another study conducted by Smith *et al.* [2]. In their study, 68% of patients who developed PPC were males. This corroborates our initial findings, indicating that there is a higher likelihood of PPC occurrence in males than in females.

It was also observed that 45% of the patients suffering from diabetes mellitus and 15% of the patients suffering from hypertension developed PPC. This observation suggests a potential correlation between these comorbidities and the progression to PPC. To provide context to this finding, we can compare it to a similar study conducted by Serejo *et al* [15]. In their study, it was found that 48% of the patients had at least one diagnosed comorbidity, and this result was statistically significant with a p-value of less than 0.05. This finding aligns with our study's observation, suggesting that comorbidities could be a significant factor in the development of PPC.

BMI was categorized based on WHO classification. It was observed that 8 (40%) of the patients, who were underweight with BMI of <18.5 had developed PPC. 7 (35%) patients were between 18.5% and 24.9%. The p-value of the study was 0.02 having significance. In the study by Serejo *et al.* [15], BMI was categorized as eutrophic (BMI 21kg/m^2 ≤30kg/m^2) and dystrophic (BMI<21kg/m^2 or ≥30kg/m^2) and it was observed that 40% of the patient who developed PPC belong to the dystrophic category.

Our study, focusing specifically on patients with peptic perforation, observed a high incidence of PPCs, with 35% (7 out of 20) of patients experiencing these complications. This finding suggests that peptic perforation may be a risk factor for developing PPCs. Further supporting this observation, a study by Smith *et al.* [2], which encompassed all laparotomies, found that emergency laparotomies were associated with the highest rate of PPCs, occurring in 18.5% of cases. This suggests that the urgency of the surgical intervention itself may contribute to the development of PPCs. Toshniwal's study provides additional insight, highlighting duodeno-gastric perforations as the most frequent reason for laparotomy. Notably, the majority of PPCs in this study developed in patients with these perforations. This finding reinforces the association between specific surgical procedures and the risk of PPCs [16].

The commonly used type of anaesthesia in our study was general anaesthesia in 54% of patients. Out of which 13 patients developed PPC. In the study conducted by Pederson *et al.* [17], of the patients admitted to major surgery receiving pancuronium, 12.7% developed postoperative pulmonary complications, compared to only 5.1% receiving atracurium. In patients having regional anaesthesia, only 1.9% developed postoperative pulmonary complications ($p<0.05$ compared to general anaesthesia).

In our study, 57% of patients underwent surgery for a duration of 1 to 2 hours and 26% of patients for less than 1 hour. By chi-square test, the p-value is <0.001, hence there is a significance between the duration of surgery and the development of PPC. In the study by Serejo *et al.* [3], 30% of the PPC patients underwent surgery for >120 minutes. In another study, PPC developed in those patients whose operative time was >3.2 hours [16].

CONCLUSIONS

The study highlighted a significant incidence of post-operative pulmonary complications in patients undergoing laparotomy, with 20% of the participants developing these complications. Male patients and individuals with comorbidities, particularly diabetes mellitus and hypertension, were at a higher risk of experiencing PPC. Patients who developed PPC also had a longer duration of hospital stay. The presence of PPC was significantly associated with increased morbidity and mortality rates. Interventions to prevent and promptly manage PPC are crucial in improving patient outcomes and reducing healthcare burden. Proper perioperative care and monitoring play a key role in reducing the occurrence of PPC. Further research focusing on preventive strategies for PPC is warranted to enhance patient care in similar settings.

CONTRIBUTION OF AUTHORS

Research concept- Nilotpal Chakma

Research design- Nilotpal Chakma

Supervision- Nilotpal Chakma
Materials- Nilotpal Chakma, Banupriya P, Nazaru Debbarma
Data collection- Nilotpal Chakma, Banupriya P, Nazaru Debbarma
Data analysis and Interpretation- Nilotpal Chakma, Banupriya P, Nazaru Debbarma
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Critical review- Nilotpal Chakma
Article editing- Nilotpal Chakma, Banupriya P, Nazaru Debbarma
Final approval- Nilotpal Chakma

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