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Original Research Article

Study of post-operative pulmonary complications in patients of emergency abdominal surgeries

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ABSTRACT

Background: Post-operative Pulmonary Complications (PPCs) form a significant chunk of post-operative morbidity. Their incidence varies from 2.7-23% in multiple studies. Pre-disposing factors can be divided as: pt. related: >60yrs, ASA class≥2 and COPD; procedure related: long surgeries (≥3hrs), emergency surgeries. Till now, most of the studies have focused on elective surgeries. In this study, I have studied morbidity and risk factors of PPCs in emergency abdominal surgeries.
Methods: It is a retrospective case control study, carried out in 50 patients in M.B. Government Hospital, Udaipur over 1 year. Cases comprised of those patients who underwent emergency laparotomy and developed PPCs. Controls were selected from group who didn't develop PPC.
Results: Incidence of PPCs in emergency abdominal surgeries was found to be 2.9%. Elderly patients had more chances of developing PPCs. Smoking was found to be twice as common in case group. Those who quit smoking ≥1 year before surgery benefitted the most. Pre-OP chest x-ray abnormalities were 3 times more common in case group. Upper abdomen surgeries were 20% more common in Case group. Surgeries lasting for ≥ 3 hours had increased chances of PPCs. Total hospital stay was 21.7 days in cases (12.5 in control), total ICU stay was 8.5 days (1.4). 28% of the PPCs patients could not be saved.
Conclusions: Pre-operative chest examination, cheat x-ray and regular SpO_2 monitoring helps in diagnosing PPCs earlier. Early mobilization and deep breathing exercises should be encouraged.

Keywords: Morbidity, Post-operative pulmonary complications (PPCs), Risk factors

INTRODUCTION

Post-operative pulmonary complications are common, serious and expensive.[1] Although PPCs are not as well studied as cardiac complications, they are just as common and even more morbid. Fleishmann et al found incidence of PPCs as 2.7% vs 2.5% of cardiac complications.[2] A prospective longitudinal study (1988-89) of 1000 patients was done in Royal Perth hospital found overall incidence of PPCs as 23.2%.[3] PPCs carry more length of hospitalization and incur more expenses to the patients. For these reasons, identifying patients at risk for pulmonary complications and developing a strategy to reduce the risk is clearly warranted. Most of the research on PPCs has focused on elective surgeries when surgeon has time to manage the risk factors pre-operatively.

But emergency surgeries don't allow that luxury. So, doing a similar study in emergency patients was needed. Definition of PPCs is still to be agreed upon.[4] Brunn et al, adapted a clinical definition from Seymour and Pringle which is minimum of 2 criteria be documented as present on ≥2 days anytime during 1st 6 Post op days:[5,6]

- New cough/sputum production.
- Abnormal breath sounds as compared with baseline.
- Temp>38^{0}C.
- Chest X-ray documentation of atelectasis or new infiltrate.
- Physician documentation of atelectasis or pneumonia.

Causes

Many PPCs such as atelectasis and pneumonia seem to be related to disruption of normal activity of respiratory muscles. Multiple regions of atelectasis develop in nearly all patients after few minutes of anesthesia and may significantly impair pulmonary exchange.[7] These intra operative changes in pattern of breathing can persist in post-operative period, as additional effects of surgical trauma come into play. Effects of surgical trauma are most profound after thoracic and abdominal surgery and arise from at least 3 mechanisms:[4]

- Functional disruption of respiratory muscles by incision
- Post-operative pain
- Stimulation of viscera decreases phrenic motor neuron output, thus decreasing activation of diaphragm and respiratory muscles.

Prevention of perioperative pulmonary complications

Avoid broncho-constriction in laryngoscopy and intubation by using inhaled β_2 agonists, muscarinic antagonists. Give regional anesthesia instead of general whenever possible. Another goal which has attracted attention recently is post-operative analgesia.[4]

Risk factors

According to ACP (American College of Physicians) guidelines 2006, Prospective risk factors are broadly classified into patient related factors and procedure related factors.

Pulmonary complications differ from cardiac complications in important way. Procedure related factors are more predictive of pulmonary complications than are patient related factors. Even healthy patients undergoing high risk surgery are at risk for pulmonary complications.[8]

- Patient related: The effect of advanced age becomes particularly notable after 60yrs and escalates from there. Even older patients ≥60 who are healthy are at increased risk. COPD and smoking are only minor risk factors.
- Procedure related: Surgical site is the most important risk factor. More the incision closer to diaphragm, more the risk. Other factors are emergency surgery, surgery lasting more than 3 hours, use of general anesthesia and multiple transfusions.

Table 1: Risk factors for post-operative pulmonary complications.[8]

	Patient related factors	Procedure related factors
Good evidence	Advanced age	Upper abdominal surgery
	ASA class≥2	Emergency surgery
	Functional dependency	Use of general anesthesia
	COPD	
Fair evidence	Weight loss	Peri operative transfusion
	Altered sensorium	
	Abnormal chest examination	
	Cigarette smoking	
Good evidence against being a risk factor	Obesity	
	Well controlled asthma	
Insufficient data	Obstructive sleep apnea	

Interventions to reduce PPCs

After several RCTs, meta analyses, systemic reviews following strategies have been selected as per ACP guidelines, 2006.[9]

Table 2: Strength of evidence for strategies to reduce risk of post-operative pulmonary complications.[9]

Evidence	Strategy
Good evidence	Post-operative lung expansion modalities
Fair evidence	Short acting Neuro muscular blockade Selective post-operative Naso gastric tube use
Balance of benefit and harm is too close to justify recommendation	Laparoscopic (versus open) operation
Insufficient or conflicting data	Intra operative neuraxial blockade Post-operative epidural analgesia Smoking cessation

The only strategy that was supported by good evidence was post-operative lung expansion modalities which comprise incentive spirometry, deep breathing exercises, intermittent positive pressure breathing and CPAP. Deep breathing and coughing exercises keep alveoli open and functioning and promotes better lung expansion. Thus, improving perfusion and gas exchange.[10] Whether preoperative smoking cessation reduces pulmonary complication rates has been controversial. Patients who quit smoking shortly actually reported increased coughing and sputum production for 1st month and two. While the effectiveness of post-operative lung expansion techniques is undisputed, preoperative lung expansion also known as inspiratory muscle training has recently been investigated and showed positive results.

Objectives of this study are to the study morbidity of pulmonary complications in emergency abdominal surgeries in Indian scenario. And to evaluate the risk factors for predicting pulmonary complications after laparotomy.

METHODS

This is a retrospective case control study conducted at Surgical ICU and General Surgery Wards of M.B. Government Hospital, Udaipur for 1 year (2017).

Study subjects

Sample size was 50 patients.

Cases

950 patients underwent emergency laparotomy in our hospital in 2017. 32 patients developed post-operative chest complications in 2017. 25 out of these were randomly selected as cases.

Controls

Out of all patients who underwent emergency laparotomy in 2017 and didn't develop post-operative chest complication, 25 were randomly selected as controls.

Children <15 years were excluded from the study.

Study methodology

Detailed history was taken and examination of patients at risk of developing post-operative pulmonary complications was done. Patients who developed PPCs were followed up closely with repeated clinical examination, chest X-ray, SpO_2 monitoring, ABG and sputum examination. Physician reference was done to confirm about chest complications and their further management. In the end, collected data was analyzed to assess significance of suspected risk factors.

Variables for comparison

Following variables were used for comparison:

- Age
- Smoking (in pack years)
- BMI
- Smoking cessation period
- Pre-operative clinical, radiological and saturation abnormalities
- Duration of surgery (in hours)
- Surgical incision (length in comparison to umbilicus and distance from xiphisternum)
- Type of surgery (upper abdomen or lower abdomen)
- Extubation of patient possible or not.
- Post-operative mobilization (day of standing)
- Duration of ventilatory and oxygen support
- Duration of ICU and total hospital stay
- Mortality

Statistical analysis

p-value calculated via Chi-square test. Relative Risk (RR) calculated for smoking habit.

RESULTS

Overall incidence of PPCs in emergency abdominal surgeries was 2.9%.

Age

Elderly age group had more chances of developing PPCs (p=0.1) (Figure 1).

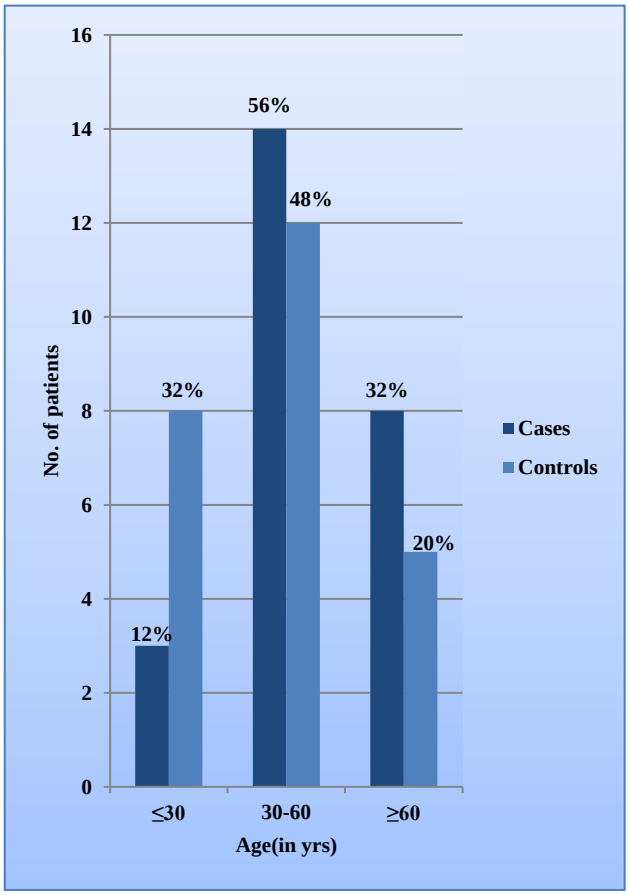

Figure 1: Age distribution comparison.

Smoking

As per expectations it was more prevalent (44%) in case group. Though control group had 24% patients who used to smoke but they all had quit smoking well before their surgery (Figure 2).

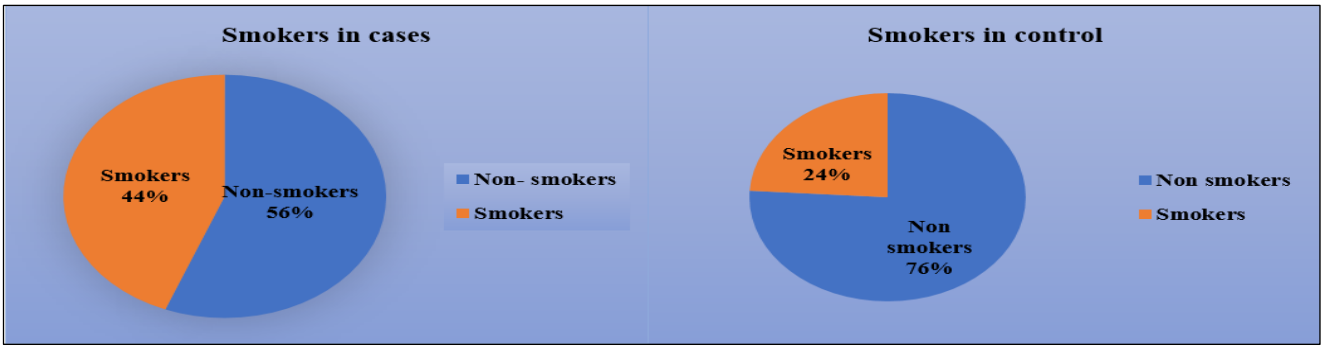

Figure 2: Habit of smoking comparison (p=0.2, RR=1.5).

Smoking intensity

Chronicity (pack years) was also found to be much more in case group.

More than 50% of smokers in case group were smoking for ≥40yrs.

While the control group smokers had past h/o smoking usually less than 30yrs (Figure 3).

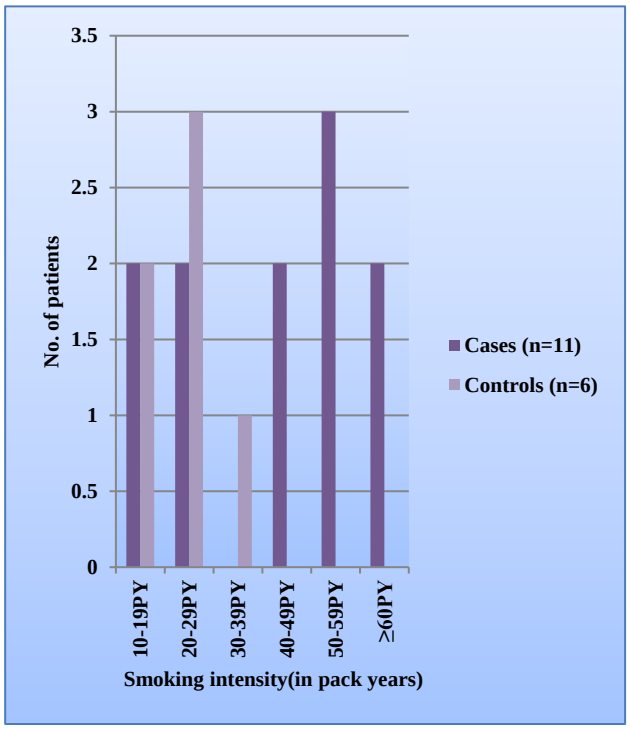

Figure 3: Smoking intensity (in pack years).

Effects of quitting smoking

All the smokers in control group had incidentally quit smoking ≥1 year before surgery. And they benefitted from it (Figure 4).

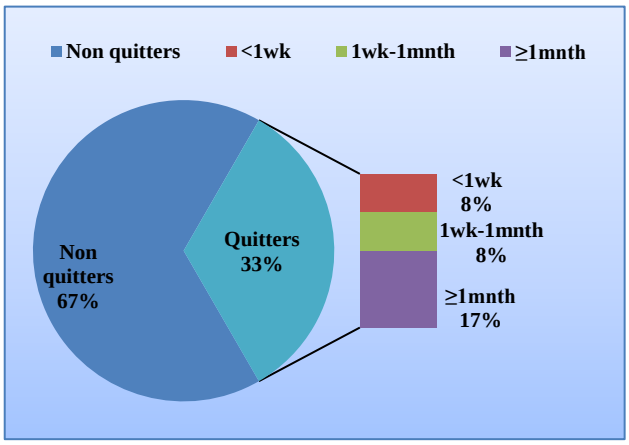

Figure 4: Percentage of smokers who quit and cessation duration before surgery (case group).

Past history of previous respiratory disease

It was present in 28% of the cases as compared to 8% in the controls. COPD was the commonest disease in case group affecting 16% (Figure 5).

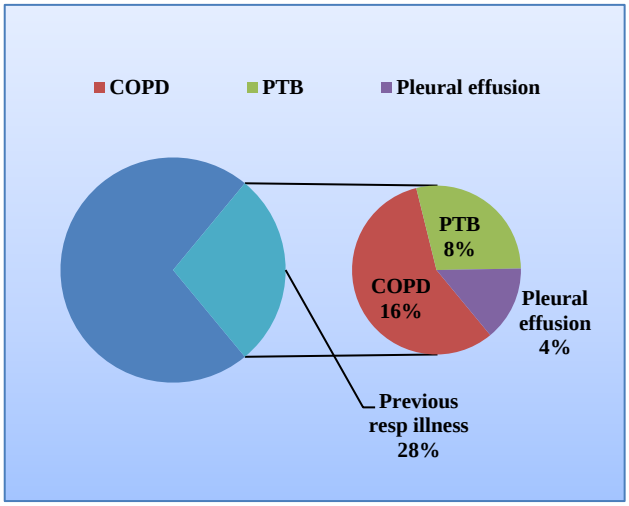

Figure 5: Previous respiratory illness (case group).

Respiratory rate

More than half (56%) of the cases had tachypnea while 92% of the control group had normal RR.

Pre-op abnormal clinical examination

Clinical examination was abnormal in 2/3rd of cases. But being a subjective indicator, it was difficult to assess the severity of pre-op respiratory compromise.

Saturation on the day of examination

1/4th of the cases had low saturation levels. SpO_2 levels <85 were found in cases only whereas patients having SpO_2 levels ≥85 were comparable in cases and control group (Figure 6).

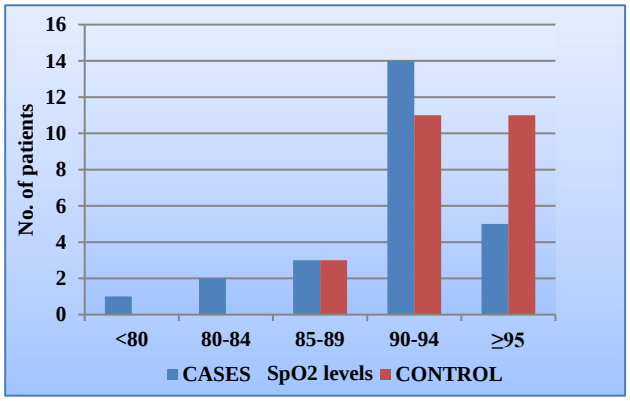

Figure 6: SpO2 levels on the day of admission.

Serum albumin

Most of the patients in both Cases and Control group had serum albumin ≥3 g/dl. So, comparison was difficult.

Pre-op X-ray changes

Pre-operative abnormal X-ray changes were 3 times more common in Case group as compared to control group. So, Chest X-rays should also be done along with abdominal x-rays in emergency (Figure 7 and 8).

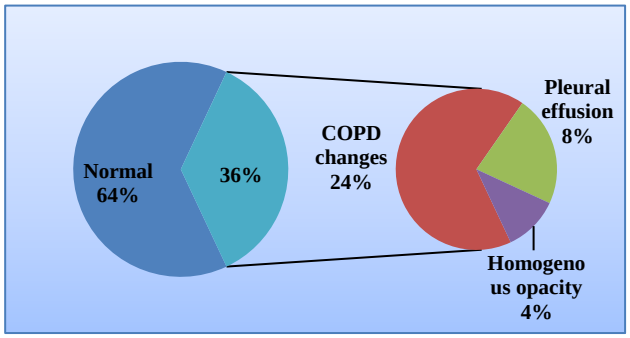

Figure 7: Pre-operative chest skiagram changes (case group).

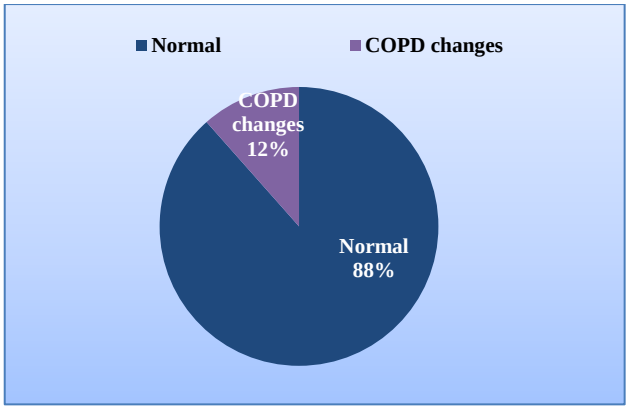

Figure 8: Pre-operative chest skiagram changes (control group).

Distribution of surgeries

Patients having upper abdominal pathologies had more chances of developing post-operative pulmonary complications (Table 3).

Table 3: Distribution of surgeries in cases and control group.

	Cases	Control
Duodenal and gastric perforation	17 (68%)	9 (36%)
Small bowel perforation	5 (20%)	11 (44%)
Colonic perforation	-	1 (4%)
Bowel gangrene	2 (8%)	1 (4%)
Rectal prolapse	1 (4%)	-
Ileal band	-	1 (4%)
Ileal stricture	-	1 (4%)
Irreducible umbilical hernia	-	1 (4%)
Total	25	25

Duration of surgery

Most of the surgeries in case group lasted for ≥3 hours (Figure 9).

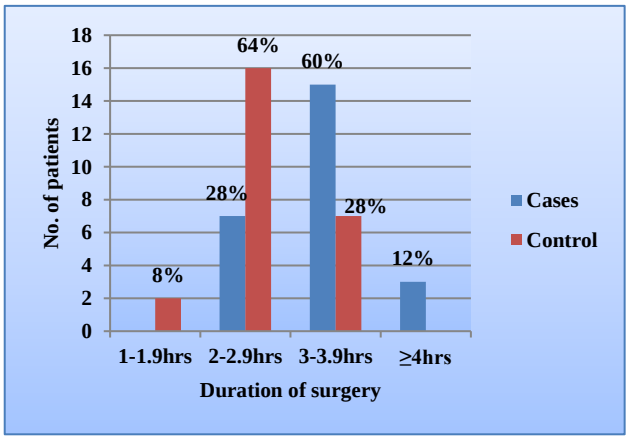

Figure 9: Duration of surgery.

Incision distance from xiphisternum

Eighty-eight % of the incisions in cases were ≤5cm from xiphisternum, while 80% of the incisions in controls were ≥6 cm away.

Average total length of incision and distance from xiphisternum

The length of incision in case group is 13% more as compared to control group. While average distance from xiphisternum is 32% less in cases than control group (Figure 10).

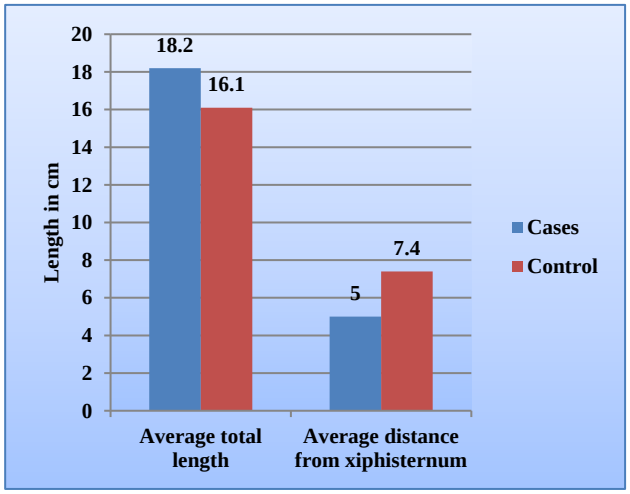

Figure 10: Average total length of incision and distance from xiphisternum.

Post-op recovery from anesthesia

Forty-eight % of the cases could not be extubated inside OT and had to stay intubated in ICU. While all the control patients were extubated and shifted from OT on room air.

Post-op distribution of low saturation levels

Forty-four % of the cases had ≤80% SpO_2 levels.

Preoperative and postoperative low O_2 saturation levels (<90%)

In case group was 24% and 68% respectively whereas in control group it was same. It is likely that physical stress during intra op period aggravated sub clinical respiratory illnesses which couldn't be detected pre-operatively (Figure 11).

Day of mobilization

Eighty-eight % of the control patients were able to stand on POD-4 as compared to 24% in case group. Few patients were told to avoid standing due to traumatic solid viscera injuries.

Distribution of clinical abnormalities in post-operative period

Crepitations were the most common abnormal examination findings (80%). Their incidence differed b/w pre-op and post-op period.

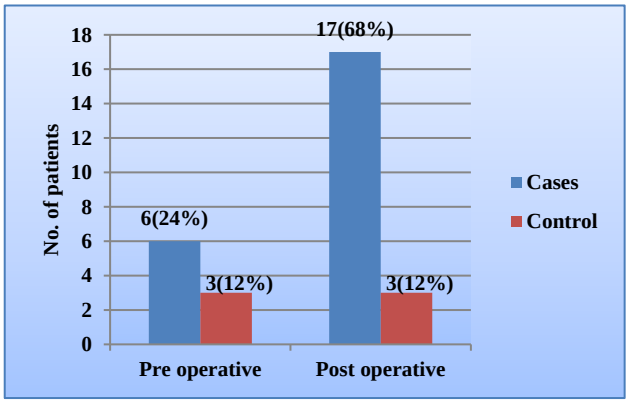

Figure 11: No. of patients with low SpO_2 levels (<90%).

Distribution of PPCs

Pleural effusion and Pneumonia accounted for half of the cases (48%). While U/L pleural effusion was more common, pneumonia was more common bilaterally. 32% of the cases could not be diagnosed specifically under any pathology. Most of them had exacerbation of previous COPD (Figure 12).

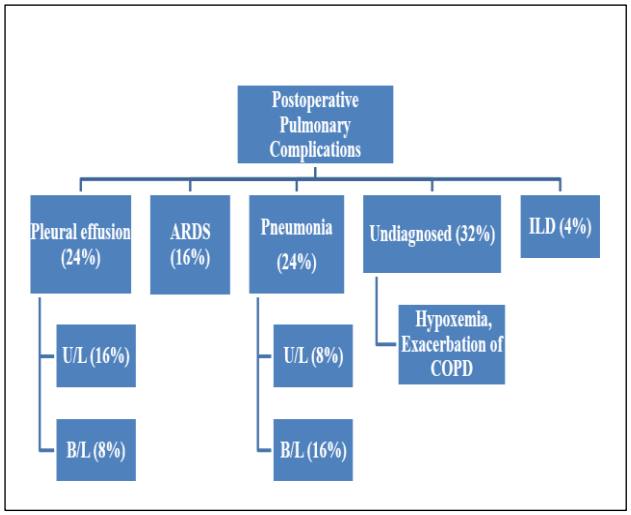

Figure 12: Distribution of post-operative chest complications.

Morbidity indices

Average ICU stay in case group was 8.5 days in comparison to 1.4 days in control group. Average duration of ventilatory support in case group was 1.7 days. Average duration of O_2 support in case group was

5.7 days in comparison to 0.8 days in control group. Average total stay in case group was 21.7 days in comparison to 12.5 days in control group. Thus, patients who developed post-operative chest complication had to stay 7 more days in ICU, 2 extra days on ventilator, 5 days more on oxygen. Overall, PPCs extended hospital stay by 10 days (Figure 13).

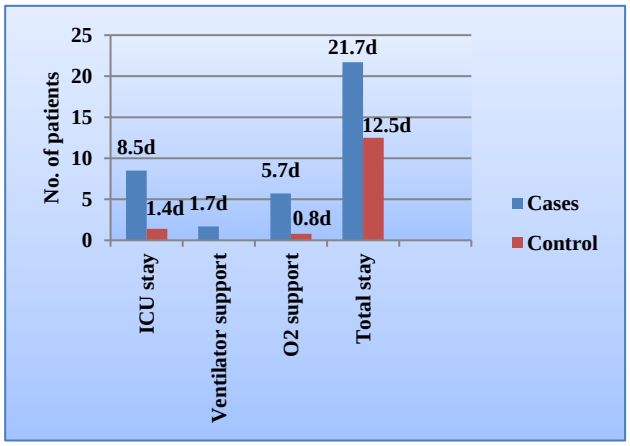

Figure 13: Morbidity indices comparisons.

Mortality

28% (7) mortality was exclusively seen in cases.

DISCUSSION

Age

Like many prospective studies, age ≥60 years was found to be an important risk factor for PPCs. Hall et al published in Chest journal (1991) that ASA classification>1 and age>59 could predict 88% of the patients who will develop PPCs.[11] ACP guideline, 2006 have also placed advanced age in the category of Risk factors which are supported by good evidence.[8]

Smoking

Smoking in present study was found to be twice as common in case group. Similar findings were noted almost all studies. Blumen et al in Chest, 1998 told a 6-fold increase in risk of PPCs in smokers. But the main focus now is on how much smoking (in pack years) increased the risk and how much cessation before surgery decreased the risk.[12] In present study, all the smokers in control group (24%) had quit smoking >1 year before surgery and all of them had smoked ≤40 pack years. In case group, 64% of smokers had smoked for ≥40 years. British Journal of Surgery published a review of 11 randomized controlled trials (Thomsen et al) in 1194 patients which showed that smoking cessation intervention significantly reduced the occurrence of post op complications.[13]

Moller et al in Lancet 2002 published after randomized controlled trial in 120 patients that post op complications in smoking intervention group reduced by 34% and smoking cessation should be done 6-8wks before surgery.[13] But in emergency scenario, that is not possible. ACP guidelines, 2006 also consider smoking as a risk factor of fair evidence.[8]

BMI

Most of the studies couldn't associate obesity with PPCs. ACP guidelines, 2006 also find good evidence against being a risk factor. Present study couldn't compare this risk factor as most of the patients were not obese.[8]

Previous respiratory illness

It was 3 times more common in Case group, COPD being most common. ACP guidelines also place COPD in Risk factors of good evidence category.[8] But the duration of illness before surgery was not specified by most of the studies. This may get clear in time to come.

Pre-op chest examination

It was abnormal in 2/3rd of present cases (crepts being most common) while 92% of the Controls had normal chest examination. Valerie et el Chest, 2006 did a case-control study in 164 patients and found abnormal clinical findings to be a risk factor (p=0.045). But, chest examination is a very subjective criterion.[14] So, authors tried Respiratory rate and SpO_2 as comparison variables.

More than half of cases had tachypnea, while 92% of the control had normal respiratory rate. SpO_2 ≥85 fared equally in both groups but patients having SpO_2 <85 were from case group only. So, it is inferred that many patients with subclinical lung compromise in pre-op period may show normal saturation levels due to increase RR compensation. So, counting RR precisely over 1min fully is important.

Pre-op chest X-ray abnormalities

Figure 14: Pre-op COPD changes.

These were 3 times more common in case group, COPD being most common. Valerie et el Chest 2006 also found abnormal chest findings to be a significant risk factor (p value=0.038).[14] So, chest X-ray must be done along with abdominal x-rays in emergency scenarios.

Pre-op Serum albumin

Annals of int medicine, 2006 found S. albumin <3 g/dl to be significant risk factor[8]. But most other studies didn't find any significant association. Since, most of present patients had S. albumin <3 g/dl so comparison was not possible.

Incision and type of surgery

Upper abdomen surgeries were 20% more common in case group. Distance from xiphisternum was found to be more important than total length of incision. Hall et al Chest, 1991 did a prospective study in 400 patients. They found that upper abdomen surgery was a significant risk factor (p=0.0001).[15] Brunn et al, Chest 1997 found in 400 patients that incisions >30 cm and closer to diaphragm had more chances of leading to PPCs (0.026). Gastro duodenal surgeries were found more common in case group as compared to bowel surgeries. In present study, authors found similar results.[5] ACP guidelines also place abdominal surgeries and prolonged surgeries in risks of good evidence category.[8]

Duration of surgery

ACP guidelines place prolonged surgeries in Risk factor of good evidence category but what duration increases the risk is not mentioned.[8] In present study, in surgeries lasting >3 hours chances of PPCs increased. Brunn et al Chest 1997 found that duration>4hrs was a significant risk factor (p=0.0062).[5]

Figure 15: Post-operative chest retractions.

Post-operative extubation possibility

Present study found that those patients who had to be shifted to ventilator or T-piece in ICU had more chances of developing PPCs. This variable has not been considered in studies so far. It is a subjective criterion as sometimes recovery of patients from anesthesia is prolonged regardless of lung compromise.

Post-operative abnormal clinical findings

Eighty % of the cases had crepitations, most probably due to increased secretions. Decreased air entry was found in 20% of cases, may be due to atelectasis.

Post-op SpO_2 levels

These were monitored daily for 5 days. 64% of the Cases recorded low SpO_2 levels in contrast to 24% in pre-op period. It shows that physical stress during intra op period aggravated subclinical respiratory compromise which couldn't be detected preoperatively. So, SpO_2 measurement was found to be easy and effective way to monitor PPCs. It must be done pre-operatively to set a baseline.

Mobilization of the patient

Present study affirmed the fact that early mobilization decreases the chances of PPCs. Average duration to standing, cases; controls was POD-5; 3 respectively.

Morbidity indices

Four indices were considered- total ICU stay, ventilator stay, O_2 support duration and Total hospital stay. Comparison with one study of Valerie et al Chest,1996 in 164 patients of elective abdominal surgeries is as follows:[14]

Table 4: Comparison of morbidity indices.

	Valerie et al cases	Present cases	Valerie et al controls	Present controls
Total hospital stay	26.4	21.7	10.5	12.5
Total ICU stay	6.3	8.5	1.5	1.4
Ventilator stay	3.2	1.7	0.2	-
O_2 support	-	5.7	-	0.8

Mortality indices

Twenty-eight % of the patients who developed PPC couldn't be saved.

Limitations of this study were sample size (50) could have been more if study span extended few more years. Small sample size decreased the significance of statistical analysis. Population mostly consisted of males (95%). Pulmonary function tests via spirometer were not possible in emergency cases. Anesthetic parameters- type

of anesthesia, post op analgesia could not be compared as they remained same in most of the patients.

CONCLUSION

In conclusion, PPCs affected elderly, smokers, and COPD patients more. Procedure related risk factors were Upper abdomen surgeries and prolonged surgeries. Early prediction of PPCs can help by starting lung expansion modalities in high risk groups. PPCs considerably increase the Hospital, ICU stays. Though it is difficult to reduce the risk in emergency surgeries, but following interventions can help:

- Detailed Chest examination of patients with skiagram chest must be done who are being planned for abdominal surgeries. Anesthetist should preferably try to categorize patient in ASA classification. Chest physician evaluation should be preferably done.
- Patient and relatives of high risk groups should be counseled regarding possibility of Post-operative chest complications, ventilatory support or O_2 support.
- Pre-operative SpO_2 should be measured to set a baseline for post op comparisons.
- Post-operative chest examination and regular SpO_2 monitoring help in diagnosing PPCs earlier thus enabling use of lung expansion modalities earlier.
- Early mobilization and deep breathing exercises should be encouraged.

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