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PREOPERATIVE PULMONARY EVALUATION FOR POSTOPERATIVE PULMONARY COMPLICATIONS IN PATIENTS UNDERGOING ELECTIVE ABDOMINAL SURGERIES

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Abstract: Postoperative pulmonary complications are common and infer greater risk of morbidity and mortality to surgical patients. Careful preoperative evaluation can identify undiagnosed and undertreated illness and allow for preoperative intervention. Hence the present study was conducted to determine the postoperative pulmonary complications occurring in the study population and to assess the correlation between the preoperative pulmonary evaluation findings and the postoperative pulmonary complications occurring in the study population.

Keywords: Pulmonary complications, Pulmonary evaluation, Abdominal surgeries

Introduction: Postoperative pulmonary complications constitute a significant cause of morbidity and mortality following surgery. Managing patients at risk for postoperative pulmonary problems requires an understanding of the predictable changes in pulmonary physiology that occur with surgery and anaesthesia, as well as knowledge of factors associated with development of postsurgical respiratory compromise.[1]

Despite the availability of several screening tests, a careful history and physical examination continue to be the cornerstone of preoperative pulmonary evaluation. Although a

number of measures can be employed before and after surgery to minimize the risk of respiratory complications, close patient monitoring and early detection are essential.[2]

In a study of patients undergoing elective abdominal surgery, as an example, pulmonary complications occurred significantly more often than cardiac complications and were associated with significantly longer hospital stay.[1] The National Surgical Quality Improvement Program (NSQIP) also found that postoperative pulmonary complications were the most expensive of major postoperative medical complications (including cardiac, thromboembolic, and infectious) and resulted in the longest length of hospital stay.[3]

The goal of perioperative pulmonary management is to identify patients at high risk of significant postoperative pulmonary complications, so that appropriate interventions can be provided to minimize that risk. In most cases, even in high-risk patients, the procedure can be performed safely as planned, but occasionally postponement, modification, or cancellation are warranted.[4]

Preoperative pulmonary evaluation plays an important role in assessing risk of developing postoperative pulmonary complications for patients undergoing abdominal surgery. Postoperative pulmonary complications are as prevalent as cardiac complications and contribute similarly to morbidity, mortality, and length of hospital stay.

Our study is an attempt to understand the role of preoperative pulmonary evaluation and its correlation with in postoperative pulmonary complications in patients undergoing elective abdominal surgeries at Rajarajeswari medical college and hospital, Bengaluru.

Methodology:

Study Group: Present Observational study was conducted on 70 patients posted for elective abdominal surgeries at Rajarajeswari medical college and hospital, Bengaluru was. Study approved by hospital ethics committee.

Inclusion criteria:

- Patient who underwent elective abdominal surgeries during the time period from November 2015 to May 2017.
- Adult patients aged 18 years and above.
- Patients who are willing to participate in the study.

Exclusion criteria:

- Patients who underwent cardiothoracic, Spine, Orthopaedic, Obstetric, Vascular surgeries and Emergency surgeries.

Study Protocol:

a. All the patients enrolled in the study were subjected to preoperative pulmonary evaluation which included thorough history taking, physical examination, chest x ray and pulmonary function tests. In certain cases, additional investigations such as ABG and DLCO (if required) were done.
b. Procedure details like duration of surgery, type of anaesthesia used and intraoperative complications were noted.
c. Postoperatively patients were followed up till discharge or 7 days, whichever was earliest.
d. During the postoperative period, relevant investigations such as chest x rays, ABG analysis and others were done as per the cases' requirement.
e. The postoperative complications, which occurred in the study group, were studied and analysed.

Statistical analysis: The recorded data was compiled, tabulated and subjected to statistical analysis. The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Results: Table no. 1 shows distribution of sample according to the age. It was observed from the present study that 16 patient were showed postoperative pulmonary complications whereas no complication were seen in 54 patients.

Of the 70 subjects studied, the mean age of the group who developed PPCs was 56.50 years, with a standard deviation of 13.44 and mean age of the group who did not develop PPCs was 48.19 years with a standard deviation of 14.45. In our study 50 % of patients who had PPCs were of age group 51-70 years. **(Table no. 2)**

It was observed from present study that among 16 patients, who developed PPCs, 10 (62.5%) were males and 6 (37.5%) were females. Among 54 patients, who didn't develop PPCs, 31 (57.4%) were males and 23 (42.6%) were females. **(Table no.3)**

In the present total study population, 13 patients complained of shortness of breath (SOB) prior to surgery. Of the 16 patients with PPCs, 9 (56.3%) had SOB and the remaining 4 (43.8%) did not have SOB prior to surgery. Among the 54 patients who did not have PPCs, 4 (7.4%) had SOB and 50 (92.6%) did not have SOB prior to surgery. **(Table no.4)**

Total 12 patients those enrolled for the study had history of cough. Among those who had PPCs, 9 (56.3%) had cough and 7 (43.8%) didn't have cough. Among those who didn't have PPCs, 3 (5.6%) had cough and 51 (94.4%) didn't have cough. **(Table no.5)**

Among those who developed PPCs, 5(31.3%) had sputum expectoration and 11(68.7%) did not have sputum expectoration. Among those who did not have PPCs, 54 (100%) did not have history of sputum expectoration. All 5 patients in the study population with history of sputum expectoration developed PPCs. **(Figure 1)**

From our study it was observed that 16 patients who developed PPCs, 7 (43.8%) were asthmatics, 3(18.8%) were COPD patients and 10(62.6%) had either asthma or COPD. Of the 54 patients who did not have PPCs, 46 (85.2%) did not have asthma or COPD.

Among the patients who developed PPCs, 4(25%) had DM + HTN, 2(12.5%) had DM, 1(6.25%) had HTN, 1(6.25%) had DM + HTN + IHD and 8(50%) did not have any pre-operative co-morbidities. Out of the 54 patients who did not have PPCs, 33(61.1%) did not have diabetes, hypertension and IHD. **(Table no.7)**

In present study, among patients who developed PPCs, 6 (37.5%) were non-smokers, 7 (43.8%) were smokers and 3 (18.8%) ex-smokers. Among those who didn't develop PPCs, 38 (70.4%) were non-smokers, 12 (22.2%) were smokers and 4 (7.4%) were ex-smokers. **(Table no.8)**

In our study 26 patients had history of smoking. Among smokers who developed PPCs, the mean of pack years was 21.20 with standard deviation of 8.95.Among smokers who did not develop PPCs, the mean of pack years was 16.69 with standard deviation of 9.46. **(Table no.9)**

Of the 16 patients who developed PPCs, 9(56.3%) had normal findings on respiratory system examination. Remaining 7 (43.8%) of them had either wheeze or crackles or both. Also, among the remaining 54 patients who didn't develop PPCs, 51 (94.4%) had normal findings on respiratory system examination and the other 2(3.7%) had either wheeze or crackles or both. **(Table no.10)**

Table no 11 shows Distribution of FEV1 and FVC**;** Among the 16 patients, who developed PPCs, 3 (18.75%) had FEV1 less than 1 litre and 13 (81.25%) had FEV1 more than 1 litre. Among the 54 patients who didn't develop PPCs, 1 (1.9%) had FEV1 less than 1 litre and 53 (98.1%) had FEV1 more than 1 litre. Among the 16 patients, who developed PPCs, 2 (12.5%) had FVC less than 1.5litres and 14 (87.5%) had FVC more than 1.5 litres. Among the 54 patients who didn't suffer from PPCs, 3 (5.6%) had FVC less than 1.5 litres and 51 (94.4%) had FVC more than 1.5 litres.

Among the patients who developed PPCs, 6 (37.5%) had normal spirometry, 6 (37.5%) had obstructive airway defect and 4(25%) had combined airway defect. Highest percentage of PPCs was in patients who had obstructive defect on PFT. Among the patients who did not have PPCs, 37 (68.5%) had normal PFT, 8 (14.8%) had obstructive defect, 8 (14.8%) had restrictive defect and 1 (1.9%) had combined defect.**(Table no.12)**

Among 10 patients who had PPCs and airway obstruction, 6 (60%) had moderate, 4 (40%) had severe obstructive defect. Among 9 patients who did not have PPCs but had airway obstruction, 2 (22.2%) had mild, 6 (66.7%) had moderate and 1 (11.1%) had severe airway obstruction. **(Table no.13)**

In present study 16 patients who developed PPCs, 12(75%) underwent upper abdominal surgeries, 4(25%) underwent lower abdominal surgeries. Among those 54 who didn't develop PPCs, 34 (63%) underwent upper abdominal surgeries, 20 (37%) underwent lower abdominal surgeries. **(Table no.14)**

Among the 16 patients who developed PPCs, in 13(81.25%) general anesthesia was used and in 3(18.8%) combined general and epidural anaesthesia was used. Among the 54 patients who did not develop PPC in 49(90.7%) patients general anaesthesia was used, in 2

(3.7%) patients' regional blocks was used and in 2 (3.7%) patients' spinal blocks was used. **(Table no.15)**

The mean duration of the duration of the procedure in those who developed PPCs was 104.06 minutes with standard deviation of 70.17 while in those who did not develop PPCs, it was 84.7 minutes with standard deviation of 46.16. **(Table no.16)**

The mean duration of postoperative stay at the hospital among patients with PPCs was 6.12 days with standard deviation of 1.36 while among patients who did not develop PPCs it was 3.37 days with a standard deviation of 1.21. **(Table no.17)**

In present study the incidence of PPCs was 22.8%. Out of the 16 patients, who developed PPCs, Atelectasis and Bronchospasm was the most common PPC with incidence of 18.75% each. Also, out of the 16 patients, 7 developed more than one PPC. Overall atelectasis (56%) was the most common complication presented individually or associated with other complications. **(Table no.18)**

Table 1: Age distribution

Age in years	PPC		Total
	Present	Absent	
<20	0(0%)	1(1.9%)	1(1.4%)
20-30	0(0%)	4(7.4%)	4(5.7%)
31-40	2(12.5%)	13(24.1%)	15(21.4%)
41-50	3(18.8%)	11(20.4%)	14(20%)
51-60	4(25%)	13(24.1%)	17(24.3%)
61-70	4(25%)	8(14.8%)	12(17.1%)
>70	3(18.8%)	4(7.4%)	7(10%)
Total	16(100%)	54(100%)	70(100%)

Table 2: Mean Age

Variables	PPC		Total	P value
	Present	Absent		
Age in years	56.50±13.44	48.19±14.45	50.09±14.56	0.044*

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Table 3: Gender distribution

Gender	PPC		Total
	Present	Absent	
Female	6(37.5%)	23(42.6%)	29(41.4%)
Male	10(62.5%)	31(57.4%)	41(58.6%)
Total	16(100%)	54(100%)	70(100%)

Table 4: Clinical symptom – SOB

SOB	PPC		Total
	Present	Absent	
Absent	7(43.8%)	50(92.6%)	57(81.4%)
Present	9(56.3%)	4(7.4%)	13(18.6%)
Total	16(100%)	54(100%)	70(100%)

Table 5: Clinical symptom – Cough and Sputum

Variables	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		
Cough				
• No	7(43.8%)	51(94.4%)	58(82.9%)	<0.001**
• Yes	9(56.3%)	3(5.6%)	12(17.1%)	
Sputum				
• No	11(68.7%)	54(100%)	65(92.9%)	<0.001**
• Yes	5(31.3%)	0(0%)	5(7.1%)	

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Figure 1: Sputum

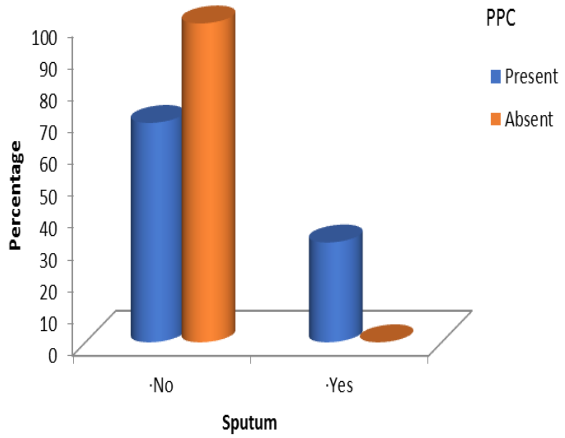

Table 6: Respiratory pre-morbidities

Variables	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		
Respiratory Pre morbidity				
• Asthma	7(43.8%)	6(11.1%)	13(18.6%)	0.001**
• COPD	3(18.8%)	2(3.7%)	5(7.1%)	
• None	6(37.5%)	46(85.2%)	52(74.3%)	

Table 7: Other premorbid conditions

Variables	PPC		Total (n=70)
	Present (n=16)	Absent (n=54)	
Other Pre Morbidities			
• Diabetes Mellitus	2 (12.5%)	8 (14.8%)	10 (14.2%)
• Hypertension	1 (6.25%)	7 (12.9%)	8 (11.4%)
• DM + HTN	4 (25%)	4 (7.4%)	8 (11.4%)
• HTN + IHD	0	2 (3.7%)	2 (3.7%)
• DM + HTN + IHD	1 (6.25%)	0	1 (1.8%)
• NONE	8 (50%)	33 (61.1%)	41 (75.9%)

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Table 8: Smoking habit

Smoking	PPC		Total
	Present	Absent	
No	6(37.5%)	38(70.4%)	44(62.9%)
Yes	7(43.8%)	12(22.2%)	19(27.1%)
EX	3(18.8%)	4(7.4%)	7(10%)
Total	16(100%)	54(100%)	70(100%)

Table 9: Number of smoking pack years

Pack of Years	PPC		Total
	Present	Absent	
<15	2(20%)	7(43.8%)	9(34.6%)
15-30	6(60%)	8(50%)	14(53.8%)
>30	2(20%)	1(6.3%)	3(11.5%)
Total	10(100%)	16(100%)	26(100%)
Mean ± SD	21.20±8.95	16.69±9.62	18.42±9.46

Table 10: Respiratory system examination findings

Variables	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		
Respiratory System				
• Crackles	0(0%)	2(3.7%)	2(2.9%)	<0.001**
• Normal	9(56.3%)	51(94.4%)	60(85.7%)	
• Wheeze	7(43.8%)	1(1.9%)	8(11.4%)	

Table 11: Distribution of FEV1 and FVC

PFT	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		

FEV1/FVC				
• <70	10(62.5%)	9(16.7%)	19(27.1%)	<0.001**
• >70	6(37.5%)	45(83.3%)	51(72.9%)	
FVC				
• <1.5 liters	2(12.5%)	3(5.6%)	5(7%)	0.347
• ≥1.5 liters	14(87.5%)	51(94.4%)	65(93%)	
FEV1				
• <1 liters	3(18.75%)	1(1.9%)	4(5.7%)	0.010*
• ≥1 liters	13(81.25%)	53(98.1)	66(94.3%)	

Table 12: PFT interpretation

Variables	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		
PFT				
• Normal	6(37.5%)	37(68.5%)	43(61.4%)	0.001**
• Obstructive	6(37.5%)	8(14.8%)	14(20%)	
• Restrictive	0(0%)	8(14.8%)	8(11.4%)	
• Combined	4(25%)	1(1.9%)	5(7.1%)	

Table 13: Staging of the airway obstruction

Grading of obstruction	PPC		Total	P value
	Present	Absent		
Mild	0(0%)	2(22.2%)	2(10.5%)	0.482
Moderate	6(60%)	6(66.7%)	12(63.1%)	
Severe	4(40%)	1(11.1%)	5(26.3%)	
Very severe	0(0%)	0(0%)	0(0%)	

Table 14: Site of surgery

Site	PPC		Total
	Present	Absent	
Upper Abdomen	12(75%)	34(63%)	46(65.7%)
Lower Abdomen	4(25%)	20(37%)	24(34.3%)
Total	16(100%)	54(100%)	70(100%)

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Table 15: Type of Anaesthesia

Variables	PPC		Total (n=70)	P value
	Present (n=16)	Absent (n=54)		
Anesthesia Type				
General	13(81.25%)	49(90.7%)	62(88.6%)	0.168
Spinal	0(0%)	2(3.7%)	2(2.8%)	
Regional Blocks	0(0%)	2(3.7%)	2(2.8%)	
General + Epidural	3(18.8%)	1(1.9%)	4(5.7%)	

Table 16: Comparison of mean duration of surgery

Variables	PPC		Total	P value
	Present	Absent		
Duration of surgery	104.06±70.17	78.98±35.94	84.7±46.6	0.058**

Table 17: Mean duration of hospital stay

Variables	PPC		Total
	Present	Absent	
Duration of hospital stay	6.12±1.36	3.37±1.21	4±1.70

Table 18: Distribution of ppcs(N=16)

PPC	Frequency (percentage)
Atelectasis	3 (18.75%)
Bronchospasm	3 (18.75%)
Pneumonia	2 (12.5%)
Pleural effusion	1(6.25%)
Atelectasis + Bronchospasm	2 (12.5%)
Atelectasis + Pleural effusion	1(6.25%)
Atelectasis + Respiratory failure	1(6.25%)
Respiratory failure + Pneumonia	1(6.25%)
Atelectasis + Respiratory failure + Pneumonia	1(6.25%)

Atelectasis + Respiratory failure + Pleural effusion	1(6.25%)
TOTAL	16

Discussion: Postoperative pulmonary complications are amongst the most common morbidities in patients undergoing major surgery. Yet, despite the frequency and potential seriousness of these complications, preoperative patient evaluation often tends to focus more on cardiac, rather than pulmonary risks.[6]

Emphasis on understanding patient and procedure related risk factors that should be considered during preoperative pulmonary evaluation, as well as strategies for reducing the risk of pulmonary complications in surgical patients are vital in terms of good patient outcome.[7]

Knowledge about PPCs and factors predicting PPCs in our local setup is lacking. We undertook this project to see the incidence and predictors of PPC in our setting and to devise strategies for their prevention. We anticipated that the above would lead to reduction in morbidity & mortality associated with PPCs and would eventually reduce the financial health care burden.[8]

Our study has shown PPC rate of 22.8% following elective abdominal surgery which means that PPCs are common in our setup. McAlister FA et al. (PPC rate of 2.7%)[10] had relatively much lesser complication rates. However, our reported rate of PPC was comparable to Fisher BW et al which reviewed seven studies (PPC rate of 2-19%),[11].

We found the commonest complication to be atelectasis 56%(individually + with other complications) and this is comparable to a study conducted by Calligaro K.D. (38%).[12] Bronchospasm was the second most common PPC occurring in 31%(individually + with other complications) of the patients. 7 patients of the study population developed more than one PPC.

Among the patient related risk factors, complaints of shortness of breath, cough and sputum production, presence of asthma and COPD, smoking pack years, abnormal findings on respiratory system examination, abnormal PFTs, low FVC and FEV1 levels were found to be statistically significant. However gender as a risk factor for development of PPCs was not statistically significant.[13]

Increasing age and increasing ASA classification was found to be an important risk factor according to a paper by Smetana published in clinic journal of medicine 2009.[14]

Age was a contributing factor to PPC in our study as also reported by Smetana GW et al, literature review does reveal that advanced age is an important predictor of postoperative pulmonary complications, even after adjustment for co-morbid conditions. A systematic review prepared for the American College of Physicians estimated the impact of age on postoperative pulmonary complications and it was observed that age more than 50 years was an important independent predictor of risk. When compared to patients less than 50 years old, patients aged more than 50 years had higher odds ratio risk of pulmonary complications after surgery.[14]

The spectrum of pre-existing chest diseases and its significance as a predictor for PPCs was comparable to earlier studies. We found chronic obstructive pulmonary disease being the most significant predictor of PPC. According to a study by Kroenke K et al. published in CHEST 1993, COPD was found to be an important risk factor for the development of PPCs.[15,16]

Physical examination findings can be helpful in assessing risk magnitude, as shown by Lawrence et al. who found that decreased breath sounds, prolonged expiration, rales, wheezes and rhonchi were each associated with an increase in pulmonary complications compared to the absence of any of these findings. The findings in our study were consistent with the above mentioned study.[3]

In a 2014 meta-analysis by Gronkjer M et al. published in Ann Surg. 2014, of 107 cohort and case-control studies, preoperative smoking was associated with an increased risk of PPCs.[17]

There is considerable debate regarding the role of preoperative pulmonary function testing for risk stratification. Preoperative Pulmonary Risk Stratification for Noncardiothoracic Surgery: Systematic Review for the American College of Physicians that evaluated 14 studies found that Spirometric values were significant risk predictors in three of four studies that used multivariate analysis. In these studies that determined the mean FEV1 values and the mean FVC values, the value was lower for patients who developed a PPC than for those who did not.[8] However in contrast to this, in a study by Brooks-Brunn JA published in CHEST 1997, of patients

undergoing abdominal surgery, there was no difference in FEV1, FVC, or FEV1/FVC between patients who had a pulmonary complication and those who did not.[18]

The procedure related risk factors which had statistical significance for causing PPCs in our study were, type of the anesthesia used and the duration of surgery. Among those who received general anaesthesia the PPCs were more. Also, the PPCs were more in those cases where duration of surgery was longer.

The cohort studies by Arozullah et al. found surgical site to be the most important risk factor in predicting postoperative pulmonary complications, with aortic and thoracic surgeries carrying the highest risk, followed by upper abdominal procedures, neurosurgery, vascular procedures and neck surgery.[19]

In our study analysis of the site of the procedure, majority of those who underwent upper abdominal procedures developed PPCs.

Systematic review by Rodgers A et al. published in BMJ 2003, reported a reduction in risk of pulmonary complications among patients receiving either epidural or spinal anaesthesia with or without general anaesthesia, when compared to those receiving general anaesthesia alone.[20] But in our study 3 of those who received epidural anaesthesia with general anaesthesia developed PPCs. It can be explained as all these patients had longer duration of surgery and the surgeries they underwent were upper abdominal surgeries.

The duration of postoperative stay at hospital was statistically significant among those who developed PPCs and those who did not. It is understandable that patients who developed PPCs needed prolonged hospitalization compared to those who did not.

In order to predict the occurrence of PPC in patients undergoing abdominal surgery, all possible risk factors should be evaluated so as to devise preventive strategies leading to reduction in the associated postoperative morbidity and mortality.[8]

Conclusions: The incidence of postoperative pulmonary complications is common and plays an important role in patient's morbidity & mortality after non-cardiothoracic surgery. The most common postoperative pulmonary complications include atelectasis, pneumonia, bronchospasm,

respiratory failure and exacerbation of underlying chronic lung disease like COPD. While clinicians may be very conscious of the importance of cardiac complications, there is good evidence to suggest that post-operative pulmonary complications are equally prevalent and contribute similarly to morbidity, mortality and length of stay in the hospital.

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