

Original Research Article

Clinical study of respiratory complications in patients undergoing elective upper abdominal surgery

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ABSTRACT

Background: Postoperative pulmonary complication is a major cause of morbidity, mortality, prolonged hospital stay and increased cost of care especially when it involves Upper Abdominal surgery. The predictable changes in lung function include a decrease in vital capacity and functional residual capacity, which are more striking in obese patients and in the supine. Aim is to study the incidence of respiratory complications in patients undergoing elective upper abdominal surgery with identification of risk factors namely Age, Sex, Obesity, Smoking and duration of upper abdominal Surgery for the development of Respiratory complications using a Peak Flow Meter as a bedside predictive test.

Methods: Peak expiratory flow rate (PEFR) measurement daily up to 7 days post-surgery, were noted to monitor the occurrence of postoperative respiratory complications.

Results: The study results according to our study showed that 14 (34.1%) male patients out of 41 had postoperative complications as compared to 15 (48.3%) out of 31 female patients. 30.5% patients were obese and had postoperative complications of 9.75%. Overall 40% of smokers had postoperative complications. Postoperatively sub costal incision had complications (41%) in 36 patients, roof top incisions 4 out of 5 (80%) and para-umbilical incisions 3 out of 4 (75%). 80% of the patients who had upper abdominal transverse incisions developed microatelectasis followed by 75% of patients who had par median incisions.

Conclusions: Respiratory complications following elective upper abdominal surgery are influenced by Increasing age and obesity and Smoking affected post-operative pulmonary recovery. Type of incision could also help change the incidence of complications.

Keywords: Abdominal surgery, Pulmonary complications, PEFR, Risk factors

INTRODUCTION

Surgeons involved in the management of patients undergoing surgery need to be aware that postoperative pulmonary complication are a major cause of morbidity, mortality, prolonged hospital stay and, increased cost of care. Patients undergoing upper abdominal surgery are particularly liable to changes in lung function and atelectasis.¹ The predictable changes in lung function

include a decrease in vital capacity and functional residual capacity, which are more striking in obese patients and in the supine.

Despite improvements in surgical and anaesthetic technique, pulmonary disorders remain the most frequent post-operative problem encountered in surgical patients. Studies that subject all patients to post-operative blood gas analysis and chest radiographs reveal alteration in

lung function in over 50% of patients after general anesthesia for cholecystectomy.² However less than 20% have abnormal clinical sings, and perhaps 10% are considered to have a clinically significant chest complications.

METHODS

Patients undergoing elective open upper abdominal surgery in the Department of general surgery at Raja Muthiah Medical College and Hospital over a period of 1 year from March 2014 to February 2015 were studied prospectively for the incidence of complications. A total of 72 patients were enrolled into this study, after satisfying the inclusion criteria and the ages of 20 and 85 years.

Inclusion criteria

- All adult patients undergoing elective abdominal surgery through upper abdominal the surgical procedure.
- Patients undergoing emergency surgical procedures.
- Patients requiring the dissection of the diaphragm as a part of the surgical procedure.

Exclusion criteria

- Patients with uncontrolled pulmonary disorders existing prior to the surgical procedure.
- Patients undergoing emergency surgical procedures.
- Patients requiring the dissection of the diaphragm as a part of the surgical procedure.

Patients were admitted and preoperatively assessed. Peak expiratory flow rates were measured using the miniature peak expiratory flow meter, after explaining the procedure to the patient.

Table 1: Definition of post-op clinical outcomes based on the criteria studied.

Criteria	Normal postop	Macroate ctasis	Microatele ctasis
Fever	1-2°F	1-2°F	3°F
Productive cough	+	+	+
Abnormal physical findings	Nil	+	+
Chests-ray findings	Nil	Nil	+

Patients were classified as having complications if they had

- Fever >99⁰F
- Productive cough

- Clinically abnormal chest findings
- Abnormal new findings on chest x-ray compared to the pre-operative X ray.

Patients were then grouped into either microatelectasis or macroatelectasis. Based on the parameters studied as mentioned in the Table 1.

RESULTS

Age incidence

Of the 72 patients enrolled into the study into study, a total of 29 patients had postoperative complications, which accounted, which accounted for 40.2% as categories in the remaining 18 patients (37.9%) and the macroatectasis were seen in the remaining 18 patients (62.1%). Among the 29 patients who had complications 14 patients (48. %) were males and 15 patients (51.7%) were females. On the whole 14 (34.1%) male patients out of 41 had postoperative. Complications as compared to 15 (48.3%) out of 31 female patients out of the total of 72 (Figure 1).

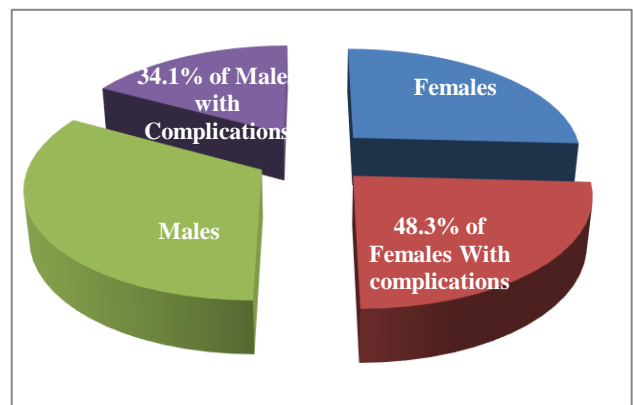


Figure 1: Complications in the study group.

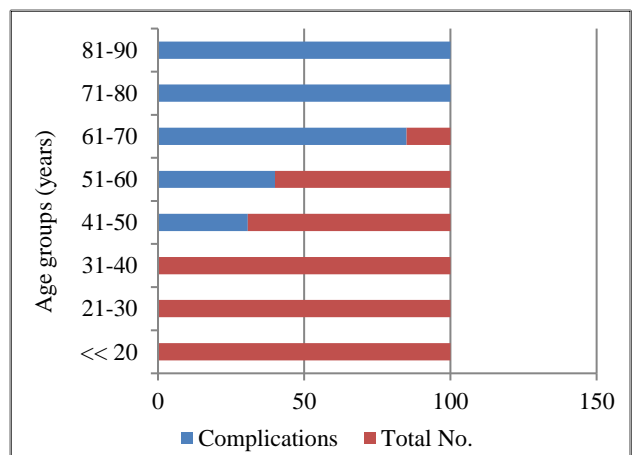


Figure 2: Percentage distribution of complications according to age.

Figure 2 shows the occurrence of complications in the different age groups. It was seen that incidence of postoperative complications increased propositionally with increasing age, especially after 50 years of age. The incidence of complications increased from 30-40% in patients <60 years to 85-100% in patients over 60 years of age as shown in the Figure 2.

Obesity

Obesity was studied as probable risk factors for the development of postoperative complications, and it was found that 22 patients (30.5%) were obese. Out of 72 patients, of whom 7 patients (31.8%) had complications post operatively. Microatelectasis was seen in 5 out of 7 patients and the remaining 2 patients had macroatelectasis. The incidence of obese patients having postoperative complications was 9.75% (Table 2).

Table 2: Complications in the obese and non-obese patients.

Patients	Microatelectasis	macroatelectasis	Normal post-op	Total no.
Obese	02	05	15	22 (30.5%)
Non obese	09	13	28	50 (69.5%)
total	11	18	43	72 (100%)

Values in parenthesis indicate % of total no. of patients in the study group (n=72).

Smoking

Smoking habits of patients in the study group and their association with post-operative respiratory complications were studied and, out of the 14 male patients who had postoperative complications 11 patients (78.5%) were smokers. With a h/o smoking in the preoperative period.

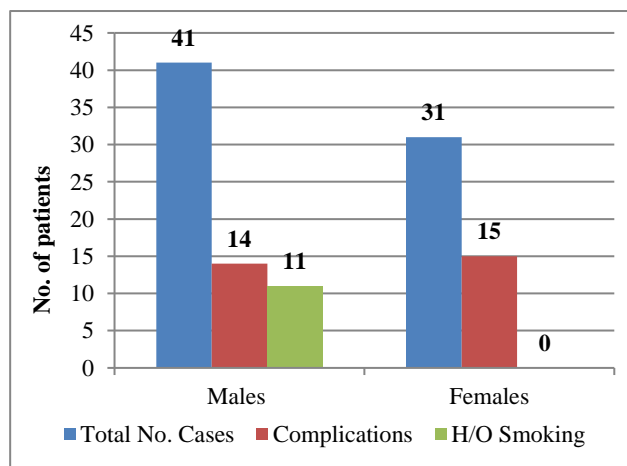


Figure 3: Distributions of complications in relations to h/o smoking.

The incidence of postoperative pulmonary complications in smokers were 39.2% (11/28). None of the female Patients were smokers (Figure 3).

Site of incision

The site of abdominal incision and its association with the development of postoperative respiratory complications showed that sub costal incision had Complications (41%) in 36 patients, roof top incisions 4 out of 5 (80%) and para- umbilical incisions 3 out of 4 (75%) as shown in the Table 3.

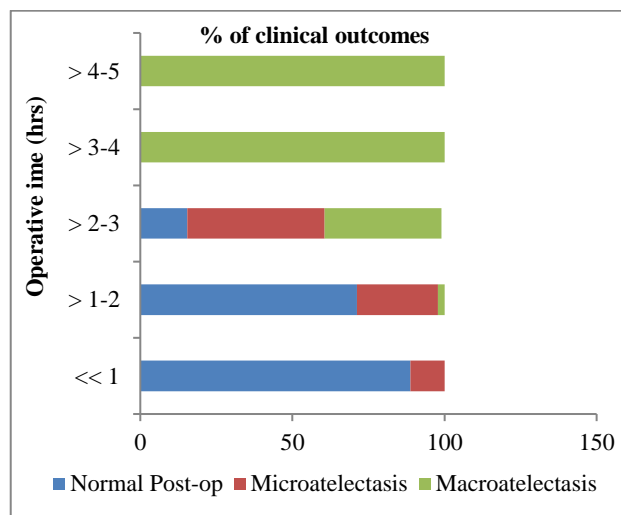
Table 3: Occurrence of atelectasis in relation to each type of incision.

Incision	Complications (%)	Frequency
Roof top	04 (80%)	05
Sub costal	07 (26%)	27
Midline	15 (41%)	36
Para median	03 (75%)	4
Total	29	72

Table 4: Distributions of the various types of incisions and the outcomes in the study group.

Incision	Macro	Micro	Normal	Total
Subtotal	2	5	22	27
Midline	5	10	21	36
Rooftop	4	0	1	05
Par umbilical	0	3	1	4

Operative time



Values in parentheses indicate percentage of total of each group placed horizontally.

Figure 4: Operative time vs pulmonary complications.

The result of operation time, and its bearing on the occurrence of postoperative pulmonary complications

showed that Microatelectasis was seen in 11 patients and macroatelectasis in 19 patients (Figure 4).

Peak expiratory flow rate (PEFR)

The result of preoperative PEFR measurement showing the distribution of macroatelectasis and microatelectasis in the study group as shown in the Table 5.

When the pre-operative PEFR values noted in the patients were less than 300Lts/min, the incidence of complications was 100%, whereas in patients with values of 300-400Lts/min, the incidence ranged from 42% - 50% and for patients with values >400 the incidence 15.3% - 20%.

Table 5: preoperative PEFR measurement vs. atelectasis.

PEFR	Microatelectasis	macroatelectasis	Total complications (%)	Total no. of patients
<250	00	00	00 (00%)	00
260-300	02	03	5 (100%)	05
310-350	05	03	8 (42.1%)	19
360-400	03	09	12 (50.0%)	24
410-450	01	01	02 (15.3%)	13
460-500	00	02	02 (20.05)	01
>500	00	00	00	01

Values in parenthesis indicate the % of complications in each PEFR group

The overall mean PEFR values of patients with complications and those without complications were noted and tabulated.

The values in patients without complications were obviously higher on all days (Table 6).

Table 6: Mean PEFR measurements in patients with and without complications.

PEFR readings op (Lts/min)	PEFR in Pts. with Atelectasis	PEFR in pts with normal Post-op Period
Pre op	361.0	403.9
Day 1	100.6	115.8
Day 2	115.5	152.7
Day 3	138.6	176.2
Day 4	162.0	199.7
Day 5	185.1	221.6
Day 6	204.1	244.4
Day 7	236.2	282.5

Statistical analysis of data on applying the 't' test

The peak expiratory flow rate measurement of patients preoperative and postoperative up to day 7 were analyzed using the student's 't' test to compare the Mean difference of PEFR values in patients with, and without postoperative complications. The mean values, standard deviation was calculated to apply the 't' test and the values were found to be significant (p <0.05) on all the days (Table 7 and Table 8).

Table 7: Statistical analysis of data using PEFR measurements as a predictive test for postoperative pulmonary complications.

Day and type	(n)	Mean PEFR	Std Dev	Std. Err Mean
Pre-op				
Complicated	29	361.03	51.92	9.64
Non complicated	43	403.95	52.51	8.01
Day 1				
Complicated	29	100.69	11.00	2.04
Non complicated	43	115.81	16.07	2.45
Day 2				
Complicated	29	115.52	13.78	2.56
Non complicated	43	152.79	22.18	3.38
Day 3				
Complicated	29	138.62	20.83	3.87
Non complicated	43	176.28	27.43	4.18
Day 4				
Complicated	29	162.07	27.78	4.97
Non complicated	43	199.77	28.58	4.36
Day 5				
Complicated	29	185.17	36.22	6.73
Non complicated	43	221.63	29.51	4.50
Day 6				
Complicated	29	204.14	36.01	6.69
Non complicated	43	244.42	31.95	4.87
Day 7				
Complicated	29	236.21	49.67	9.22
Non complicated	43	282.56	33.67	5.13

DISCUSSION

Postoperative pulmonary complications are the results of complex interactions of risk factors like age, weight, sex, pulmonary condition, and most of all, surgical procedure. Upper abdominal surgery induces a marked diaphragmatic dysfunction, lasting for about week. As a result, lung function criteria such as vital capacity and functional capacity are decreased. Roukema et al, al noted in their study that the incidence of postoperative

respiratory complications in patients without a history of pulmonary dysfunction that were of normal weight and under 70 years of age was 60%.⁹

Patients undergoing elective surgery first need to be screened for operative risks by reviewing factors that relate to the patient. And factors that relate to the procedure they are undergoing. The identification of high-risk patient undergoing high-risk procedures may be aided by reviewing the following factors: the presence of symptomatic lung disease, smoking, obesity, abnormal blood gas values, and spirometry. The more risk factors a patient has, the more likely the patient will develop postoperative complications.

Table 8: Statistical analysis of data for 'p' value.

PEFR and Type	Mean PEFR	Std dev	t	df	P
Pre-op					
Complicated	361.03	51.92	-3.417	70	<0.05
Non complicated	403.95	52.51			
Day 1					
Complicated	100.69	11.00	-4.414	70	<0.05
Non complicated	115.52	16.07			
Day 2					
Complicated	115.52	13.78	-8.051	70	<0.05
Non complicated	152.79	22.18			
Day 3					
Complicated	138.62	20.83	-6.269	70	<0.05
Non complicated	176.28	27.43			
Day 4					
Complicated	162.07	28.58	-5.629	70	<0.05
Non complicated	199.77	36.22			
Day 5					
Complicated	185.17	36.22	-4.688	70	<0.05
Non complicated	221.63	29.51			
Day 6					
Complicated	204.14	36.01	-4.985	70	<0.05
Non complicated	244.42	31.95			
Day 7					
Complicated	236.21	49.67	-4.724	70	<0.05
Non complicated	282.56	33.67			

The clinician should remember the value of a complete history and physical examination in every patient undergoing preoperative assessment with attention to the presence of unexplained dyspnea, cough, or reduced exercise tolerance. The physical examination should focus on detection of chronic lung disease with particular attestation to the presence of wheeze or Rancchi

on examination, decreased breath sounds or prolonged expiratory phase.

What constitutes a postoperative complication has been a point of debate. Some authors opine that, postoperative elevations of temperature of 1-2⁰F is the normal course of events following general anesthesia and major abdominal Surgery. Various authors have employed various definitions of postoperative complications. Development of productive cough with fever of 99⁰F or more, with physical sings on examination of chest, which were previously not present, was defined as postoperative pulmonary complications.³ Patients producing large amounts of sputum with or without pyrexia were deemed to be having postoperative complications. Lawrence VA et al, classified postoperative complications, as described in the table below.⁴

The true defined of presence of postoperative pulmonary complications is difficult to determine because it depends on the criteria set by the investigators and the parameters studied by them.

Table 9: Post-operative complications as defined Lawrence VA et al.⁴

Criteria	Normal post op	Marcroatele ctasis	Microatele ctasis
Fever	1-2 ⁰ F	>>3 ⁰ F	1-2 ⁰ F
Physical signs	Negative	Positive	Positive
Productive cough	+/-	+/-	+/-
Chest X ray	Negative	+/-	Negative

In the present study authors have categorized a patient as having postoperative complications in the presence of fever above 99⁰F, productive cough and physical sings like Rancchi or crepitating and further classified them into those with marcroatelectasis defined by Lawrence VA et al.⁴

In the present study the incidence of postoperative pulmonary complications after upper abdominal surgery was 40.2%, which was comparable to that reported by another author.

The respiratory effects of two postoperative analgesic regiments were compared in two groups of 16 patients each, recovering from general anesthesia and major surgery. Ten patients receiving morphine infusions had a total of 456 episodes of pronounced oxygen desideration (SaO₂). These occurred only when the patients were asleep. In contract, in patients receiving regional anesthesia, oxygen desideration never decreased below 87% suggesting that postoperative pain relief using regional anesthesia had a greatest margin of safely in teams of respiratory side effects than does the continuous administration of opiates.

To detect the possibility of occurrence of postoperative complications, patients need a good but relatively simple clinical examination that may then indicate the need for more formal testing aimed at assessing the severity of respiratory compromise. The end results should be a better comprehensive planning for safer surgery and a decrease in unnecessary postoperative complications.

Immediately after surgery, a decrease in P_{aO_2} occurs, which is through to be due to a ventilation perfusion mismatch, with poorly ventilated areas continuing to receive blood. This type of atelectasis is not easily appreciable on X-ray and is termed macroatelectasis.¹² In the absence of previous gas exchange abnormalities, there is no alteration on CO_2 as expected these events remain silent in the patient with normal or minimally altered baseline respiratory function, but they may result in significant pulmonary complications in those patients with pulmonary compromise (high risk).

Table 10: Incidence of post operative respiratory complications as reported by various authors.

Name of Study	No. of patients	Post-op complications	PPC %
Stein et al ⁵	63	22	34.92
Wightman et al ⁶	785	149	19%
Lyager et al ⁷	94	44	47%
Celli et al ⁸	172	82	48%
Roukema et al ⁹	84	50	60%
Brooks-Brunn ¹⁰	400	90	22.5%
Mathew JT et al ¹¹	584	82	13.9%
Present study	72	29	40.2%

In the most compromised patients, the increase work of breathing needs to maintain to adequate PaO_2 and $PaCO_2$ places further strain on the respiratory muscles.

Any failure in this mechanism leads to hypoxemia resulting in increased shunting of blood to cause a rise in the alveolar arterial oxygen tension gradient suggesting "macroatelectasis". This change can be analyzed by arterial blood gas analysis, which gives a clue regarding the pulmonary status of the patient.

In the present study patients who developed a macroatelectasis postoperative, showed a fall in the PaO_2 and a rise in the $PaCO_2$ and it was seen in other studies that the resulting hypoxemia in the post-operative period lasted for at least 7 days postoperative.¹³ An upper abdominal incision causes a greater degree of hypoxemia than does a surgery on the lower abdomen, probably by a reflex inhibition of the diaphragm.

Age and sex

In the study comparison of three methods of respiratory care following upper abdominal surgery,⁷ Jung et al, observed that atelectasis was seen in 13 patients of 36 who were subjected to IPPB, 16 out of 45 patients subjected to resistance breathing, and 22 out of 45 patients subjected to incentive spirometry as methods of preventing postoperative atelectasis.¹⁴ Though they found no statistically significant difference between the three groups, they observed that there was a statically significant higher incidence of atelectasis in patients over 50 years of age than in younger patients.¹⁵ That, increasing age rises the incidence of post-operative complications has been suggested by many authors. But Thulbourne are young (1962) found that the incidence of postoperative complications was greater in the group of patients over 70 years of age. in patients between 50 and 70 years of age the incidence of PPC was higher (51%) than in patients less than 50 years of age (30%) reported.

Roukema et al, studied pulmonary complications after upper abdominal surgery in patients with non-compromised pulmonary status and observed that there was a 60% incidence of complications in patients.⁹ As reported by him, patients over the age of 50 years were at an increased of ppc was somewhat higher in male patient than in female patient, though however statistically not significant.

Wightman et al, in his study found that the incidence of complication increased with increasing age. It was observed that a total of 8.9% had complication below the age of 70 years and 16.5% in patient above 70 years.⁶

Thoren L, found a higher incidence of complications (40%) In those patients below the age of 50 years and a lower incidence (25%) In those less than 50 years of age.¹⁶

In the present study we found that the occurrence of complication increased with increasing age as found by authors. The incidence of complication in patients below the age of 50 years was 20%.

Lawrence VA et al, in his study observed that 49.82% of males had complications and that 14.28% of female patients had complications.⁴ Roukema ET al found that men had a higher incidence of PPC than women.⁹ In a study conducted by Hall et al, they have put forward that male gender is not a significant predictor of PPC when the other factor were also taken into account.¹⁷ On the whole 34.1% of male patient had postoperative complication as compared to 48.35 female patient in our study.

Obesity

Thoren L considered the incidence of postoperative plumonary complication in relation to the weight of the

patient. Thoren L, suggested that the incidence of complications doubled in patients weighting over 70kgs.¹⁶

Limier et al, observed that, of the 19 obese patients, 42% had impairment shown on preoperative pulmonary function studies, whereas, of the 27 non-obese patients only 19.5% had impairment.¹ In present study we found that 30.5% patients were obese, whom 31.8% had complications postoperatively. The incidence of obese patients having postoperative complications was 9.75%.

Smoking

Limier et al, found in their study that 35% of those patients in whom microatelectasis developed were smoked did not influence the incidence of PPC in their selected group of patients.¹ The explanation being giving that smokers with physical sings of chronic obstructive pulmonary disease were excluded from their study.

In the present study postoperative pulmonary complications occurred more frequently in smokers compared to the non-smokers. Of the 14 male patients who had complications. 11 (78.5%) of the patients had an h/o of smoking overall 40% of smokers had postoperative complications. None of the female patients who had complications had an h/o of smoking as a risk factor for the occurrence of postoperative complications.

Site of incision

Upper abdominal surgery induces a marked diaphragmatic dysfunction lasting for above a week. An impairment of diaphragmatic mechanics induced by the abdominal surgery may be a reflex one, whereby afferent splanchnic or other sympathetic vigil discharge secondary to upper abdominal surgery may inhibit pyretic never output.¹⁸ As a result, lung function criteria such as vital capacity and functional residual capacity are decreased postoperatively, in contract to reports by other authors.

Shallow monotonous breathing without intermittent large breaths or singing may decrease ventilation. Closing volume may become greater than fundamentals residual capacity, contributing to closer of airways and atelectasis, predominantly in the dependent lung regions. Wightman et al, observed in their study that 9.3% of complications were seen with upper abdominal midline incisions and 25.2% of complications after upper par median incisions.⁶

In the present study 80% of the patients who had upper abdominal transverse incisions developed microatelectasis followed by 75% of patients who had par median incisions.

Operative time

Duration of surgery was second to, the site of operation as a risk factor for postoperative pulmonary

complications. It has been put forward that excess intraoperative manipulation of viscera has a definite relation in the development of complications postoperatively. Merely and ferguson¹⁹ shown a 40% complication rate if the operative procedure exceeded >3hrs, as compared to 23% when it was <3hrs.

As early as 1946 drips and denning considered the incidence of postoperative atelectasis and pneumonia in relation to the duration of operation; it was found that the time factor was without influence up to the end of the third hour, but there after this period the incidence of pulmonary complications rose from 4.7% to 10.2%.

Jung et al, observed in their study that the duration of surgery tended to 9 exert little influence on the success of therapy, they found that 22 patients had atelectasis out 58 patients with operative time of <2hrs as compared to 29 out of 58 patients who had operative times > 2hrs.¹⁴

In the present study all 100% of the patients who had operation times of more than 3hrs had atelectasis as compared to 11.2% of atelectasis (micro/macro) in patients with operation time <3 hrs as categorized in the study, microatelectasis was found in 11 patients (37.9%) and the microatelectasis were seen in the remaining 18 patients (62.1%).

Peak expiratory flow rate

Myron stein et al in their study of pulmonary evolution of surgical patients⁷, which included 63 patients, found that among 33 patients whose

Preoperative pulmonary function was normal, there was 1 patient with complications and in 30 patients classified as abnormal, there were 21 complications. Decreased maximal expiratory flow rates had the best correlation with respiratory complications.

Many of the predicted outcomes are clinically trivial and would not be sufficient reason for a clinician to change therapy or alter his enthusiasm for surgery.

Lawrence VA et al, noted an incidence of 100% in patients with PEFr <200lts/min., 40% with PEFr between 201 to 300 min/min, 25% with PEFr between 300-400lts/min. The author concluded that the incidence of complications increases wither measurements <200lts/min.⁴

In the patients study we found that all the patients with preoperative PEFr values of less than 300lts/min had atelectasis in the postoperative period. after statistical analysis by applying the 't' test to compare the overall mean difference in values of preoperative and postoperative PEFr readings between patients with complications, and the patients without complications, we found the values to be significant on all the days

observed, as shown in the table of results of PEFr measurements.

CONCLUSION

In conclusion, postoperative respiratory complications were found to be higher when the age of the patients was more than 60 years and when the patients had a history of smoking. Obesity was shown to be unrelated to the development of pulmonary complications, except as an additional contributing factor when present along with the other risk factors identified. Pulmonary complications were also found to be higher when the surgery involved placement of upper abdominal rooftop/transverse incisions and when the operative time was more than 3 hours, as procedure related factors.

Preoperative peak expiratory flow rates statistically significant ($p < 0.05$) and helped predicating the probability of development of postoperative pulmonary complications. PEFr values are useful in identifying patients at high risk of developing pulmonary complications in the postoperative period.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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