Preoperative Spirometry to Predict Postoperative Complications in Thoracic Surgery Patients

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Abstract

Spirometry is a simple and basic test that can provide more information about pulmonary function. Many thoracic surgeons do a spirometry test to assess the pulmonary status of their patients before surgery.

Objective: To determine if preoperative spirometry can predict postoperative complications following thoracic surgery.

Design: Retrospective case control study.

Setting: Srinagarind Hospital Medical School, Khon Kaen University, Khon Kaen Thailand.

Participants: Adult patients who had spirometry before thoracic surgery.

Measurement and results: From 1995 to 1998, we reviewed thoracic surgery patients who had spirometry testing before thoracic surgery. Fifty-six patients were enrolled in our study. Postoperative complications of these patients were determined by a systemic extraction of medical record data. The postoperative complications were classified into two groups, respiratory and non-respiratory complications. Eighteen patients experienced at least one respiratory and other complications. There was a sixfold or greater increase in non-respiratory complications (cardiac arrhythmia, congestive heart failure, prolonged hospital stay, upper gastrointestinal bleeding and wound infection), which were associated with moderate and severe impairment of FEV_1 and FVC (<66%predicted) ($p<0.05$). There was a thirty percent increase in non-respiratory complications, which were associated with FEV_1 < 2 liters ($p<0.05$), FEV_1 or FVC less than 70 per cent of predicted value ($p<0.05$). No spirometric values were a good predictor of respiratory complications.

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Conclusion: Preoperative spirometry levels in patients requiring thoracic surgery of FEV_1 < 2 liters, FEV_1 or FVC <70 per cent of predicted value was associated with postoperative complications, especially non-respiratory complications.

Abbreviation: FEV_1 = Forced expiratory volume in one second, FVC = Forced expiratory capacity

Key word : Preoperative Prediction, Spirometry, Postoperative Complication, Thoracic Surgery

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Postoperative pulmonary complications have been correlated with thoracic surgery, pulmonary disease, advanced age and a history of smoking (1,2). Patients who underwent lung resection surgery, especially for lung cancer had concomitant chronic lung disease. Preoperative spirometry is usually done before thoracic surgery to assess risk. Abnormal values of spirometry, for example a reduction of forced expiratory volume in 1 second (FEV_1) has been associated with increased postoperative complications in most but not all studies(3-6).

Our study was done to assess the relation between preoperative spirometry and postoperative complications.

METHOD

The study site was Srinagarind Hospital School of Medicine, Khon Kaen University. We performed a retrospective study carried out on patients who underwent spirometry before thoracic surgery between January 1995 and December 1998. The spirometry was done by well trained registered nurses at the Division of Pulmonary and Critical Care Medicine, Department of Medicine. The spirometry used was either Vitalograph®, Sensor Medic® system 6200 or Sensor Medic® system 2900. The spirometry was performed according to established guidelines(7).

All operations were performed by two or more of four surgeons in the Division of Cardiothoracic Surgery, Department of Surgery, and postoperative care was supervised on a thoracic or ICU surgical ward. Hospital records and chest X-rays films were reviewed to identify postthoracotomy complications which occurred at the time of hospital admission, during the postoperative hospital course.

Postoperative complications were defined as follows;

Respiratory complications included; (1) pneumonia defined by at least two of the following: temperature > 37.7°C, white blood cell count > 10,500/mm^3 and the demonstration of pathogenic organisms, plus new radiographic infiltration, (2) tracheobronchitis defined by the criteria of pneumonia above, but without new radiographic infiltration, (3) mechanical ventilation ≥ 72 hours for any reason, (4) empyema, (5) hemothorax requiring drainage or reoperation, (6) tension pneumothorax, (7) pulmonary embolism, (8) bronchopleural fistula, (9) intercostal tube drainage ≥ 14 days for any reason and (10) secretion obstruction requiring reintubation.

Non-respiratory complications included; (1) cardiac complications: arrhythmia requiring treatment, congestive heart failure and myocardial infarction; (2) general complications: hospital stay ≥ 21 days after surgery, renal failure requiring dialysis, gastrointestinal bleeding, cerebrovascular accident and wound infection.

Statistical Analyses

We recorded FEV_1, FVC, FEV_1/FVC, and divided the outcome into severity of pulmonary impairment(8) and previous predictive value (9-12) (< 70, ≥ 70% predicted or < 2 liters, ≥ 2 liters). The

postoperative complication events were recorded and filed in spirometric grouping as stated above. For statistical analysis, the proportion tests from independent groups were used to determine whether abnormal spirometry was associated with postoperative complications. Statistical significance was accepted at the $p < 0.05$ level.

RESULTS

From 1995 to 1998, 256 patients had thoracic surgery. We found that 56 patients (22%) had had spirometry before thoracic surgery and were enrolled in our study. The median age of the patients was 53 (range 15-76) years. The most common diagnosis and operation in these patients were bronchogenic carcinoma (75 %) and lobectomy (42.8), respectively. (Table 1) Eighteen patients with a median age of 45.5 (range 24-73) experienced at least one respiratory and/or non-respiratory complication. The most common respiratory and non-respiratory complication was pneumonia (26.1%) and cardiac arrhythmia (8.8%), respectively. (Table 3)

Abnormal FEV_1 by percentage of predicted and absolute value of FEV_1, the FVC revealed statistical associations with postoperative non-respiratory complications ($p<0.05$). Non-respiratory complications occured in thirty per cent more than in those having $FEV_1 < 2$ liters or < 70 per cent predicted ($p<0.05$). When grouping the patients into severity classes, we found that those having FEV_1 or FVC more than class II (<66% predicted) had six times more non-respiratory complications ($p<0.05$).

In contrast to the non-respiratory complications, the respiratory complications were not significantly associated with abnormal spirometric values. (Table 4)

DISCUSSION

Routine preoperative spirometry is usually performed on most patients scheduled for thoracic surgery with the aim of assessing their pulmonary status. A study by Hnatiuk MOW in 1995 pointed out that nearly 40 per cent of preoperative spirometry requests did not meet the American College of Physicians (ACP) guidelines and may be over-

Table 1. The diagnosis of patients who had spirometry before thoracic surgery (n = 56).

Diagnosis	Number	%
1. Bronchogenic carcinoma	42	75.0
2. Empyema thoracis	4	7.2
3. Chest wall tumor	2	3.5
4. Bronchiectacis	2	3.5
5. Interstitial lung disease	1	1.8
6. Malignant thymoma	1	1.8
7. Atypical pulmonary tuberculosis	1	1.8
8. COPD	1	1.8
9. Pectus excavatum	1	1.8
10. Foreign body in lung	1	1.8

Table 2. The type of operations for patients who had spirometry before thoracic surgery (n=56).

Operation	Number	%
1. Lobectomy	24	42.8
2. Thoracotomy	12	21.4
3. Pneumonectomy	11	19.6
4. Wedge resection	3	5.4
5. Opened lung biopsy	3	5.4
6. Segmentectomy	1	1.8
7. Blebectomy	1	1.8
8. Chest wall reconstruction	1	1.8

Table 3. The characteristic of postoperative complication* in patients who had spirometry before surgery (n=18).

Respiratory complications	Number	%	Non-respiratory complication	Number	%
1. Pneumonia	6	26.1	1. Cardiac arrhythmia	2	8.8
2. Prolong mechanical ventilation	3	13.1	2. Congestive heart failure	1	4.3
3. Tracheobronchitis	3	13.1	3. Upper gastrointestinal bleeding	1	4.3
4. Acute respiratory distress syndrome (ARDS)	2	8.8	4. Cardiac herniation	1	4.3
5. Empyema thoracis	1	4.3	5. Hemothorax required reoperation	1	4.3
6. Secretion obstruction	1	4.3	6. Prolong hospital stay ≥21 days	1	4.3

* Total complications 23 events

Table 4. Preoperative variables and postoperative complications after thoracic surgery.

Spirometric value	Respiratory complications (%)	Non-respiratory complications (%)
1. FEV1		
≥ 2 liters (n=30)	30	0*
< 2 liters (n=26)	40	30*
2. FEV1		
≥70% predicted (n=38)	40	0*
<70% predicted (n=18)	30	30*
3. FEV1 severity class		
I-II (n=41)	44	4*
III-IV (n=15)	26	26*
4. FVC		
≥70% predicted (n=38)	26	0*
<70% predicted (n=18)	44	30*
5. FVC severity class		
I-II (n=42)	48	4*
III-IV (n=14)	22	26*
6. FEV1/FVC severity class		
I-II (n=51)	57***	26
III-IV (n=5)	13***	4

* Total complications were 23 events

** $p<0.05$

*** $p=0.03$ The respiratory complications were higher in the less severe obstructive airway disease due to the large number of patients that having other variable factors of abnormal spirometric value such as low FEV_1 and/or FVC. This finding were confirm by the data that, those patients having mild obstructive airway disease (FEV_1/FVC class I-II) had less postoperative complications comparing with those having more severe obstructive airway disease (17% *versus* 83%, $p<0.0004$).

utilized[13]. The value of preoperative spirometry to predict postoperative complications is controversial[12,14-16,23]. Our study demonstrates that several preoperative spirometric values are associated with an increase in postoperative complications, especially non-respiratory complications. Our findings support the few studies of FEV_1 of less than 2 liters, FEV_1/FVC of less than 50 per cent predicted, FVC of less than 70 per cent predicted, which are associated with a high incidence of postoperative complications[9-11]. However, we can not explain why abnormal spirometry values, which reflect an abnormality mainly in respiratory function, were associated with non-respiratory complications. In addition, our findings also showed that none of the spirometric values were associated with respiratory complications, which supported the recent studies indicating that spirometry values poorly predicted respiratory complications[17-19]. Abnormal FEV_1/FVC ratio indicated patients with obstructive airway disease, such as COPD or asthma patients. Severe chronic obstructive pulmonary disease increased the operative risk associated with lung resection[1,20]. However, our findings suggest that postoperative complications, even in moderately-severe obstructive airway disease, were not significantly increased compared to those having mild obstructive airway disease. Our patients with severe COPD (FEV_1/FVC 46% predicted) underwent lobectomy without any complications. This finding was consistent with one cohort study. They stated that even in patients with severe COPD, surgery can safely be performed[21]. The severity of airway obstruction as measured by spirometry may not be an independent predictor of pulmonary complications[22,23]. This finding suggested that preoperative spirometry may not predict individual risk of complications[21,24]. Theoretically, the

explanation of why spirometric values are not good predictors of postoperative complications could be due to; (1) the reduced FEV_1/FVC ratio may not be more sensitive as an indicator of pulmonary pathology than information gathered during a careful history and physical examination; (2) the interindividual variability of the expiratory flow rate is relatively large, resulting in an overlap between normal and abnormal populations[25].

The best test for the prediction of postoperative cardiopulmonary complications appears illdefined[9]. We could not tell exactly which individual patients would have postoperative complications or the absolute percentage of the complications. We were able to discern only that the operative risks were either so high or so low by integrating all available information from clinical data and laboratory tests. We believe that spirometry is still useful for risk stratification in preoperative thoracic surgery, if it is used correctly. Limitations of our study are its retrospective design and lack of control of cointervention factors, which may influence the outcome.

In conclusion, during a 4-year operative period at our institution, we identified those patients having $FEV_1 < 2$ liters, FEV_1 or FVC, < 70 per cent predicted who had significantly increased postoperative morbidity.

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การตรวจสมรรถภาพปอดด้วย spirometry ในการพยากรณ์การเกิดภาวะแทรกซ้อนของผู้ป่วยหลังการผ่าตัดทรวงอก

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การตรวจสมรถภาพปอดด้วยเครื่อง spirometry ก่อนการผ่าตัดทรวงอกมีประโยชน์ในการตรวจหาความผิดปกติของระบบทางเดินหายใจ

วัตถุประสงค์: เพื่อหาความสัมพันธ์ระหว่างค่าการตรวจสมรรถภาพปอดด้วย spirometry กับภาวะแทรกซ้อนหลังการผ่าตัดทรวงอก

รูปแบบ: การศึกษาเปรียบเทียบย้อนหลัง

สถานที่: โรงพยาบาลศรีนครินทร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น

กลุ่มที่ศึกษา: ผู้ป่วยผู้ใหญ่ที่ได้รับการตรวจ spirometry ก่อนเข้ารับการผ่าตัดทรวงอก

การวัดผลและผลการศึกษา: จากการค้นเวชระเบียนผู้ป่วยระหว่างปี พ.ศ. 2538 ถึง 2541 และวิเคราะห์ข้อมูลอย่างเป็นระบบโดยจัดภาวะแทรกซ้อนหลังผ่าตัดเป็นสองกลุ่มได้แก่ภาวะแทรกซ้อนต่อระบบทางเดินหายใจและภาวะแทรกซ้อนอื่นๆทั่วไป เปรียบเทียบหาความสัมพันธ์กับค่าความผิดปกติของการตรวจ spirometry ที่มีการอ้างอิงว่ามีโอกาสุเกิดภาวะแทรกซ้อนหลังผ่าตัดได้บ่อย พบว่ามีผู้ป่วยที่ตรวจ spirometry ก่อนผ่าตัด 56 ราย ผู้ป่วย 18 รายพบมีภาวะแทรกซ้อนหลังผ่าตัด ผู้ป่วยที่มีค่าสมรรถภาพปอด FEV_1 และ/หรือ FVC น้อยกว่าร้อยละ 66 ของค่าคาดคะเนมีการเกิดภาวะแทรกซ้อนทั่วไปเช่น หัวใจเต้นผิดจังหวะ หัวใจล้มเหลว ต้องอยู่โรงพยาบาลนานกว่าปกติ ตกเลือดในทางเดินอาหารและบาดแผลติดเชื้อสูงขึ้นประมาณ 6 เท่าเมื่อเทียบกับกลุ่มที่มีค่าดังกล่าวมากกว่าร้อยละ 66 อย่างมีนัยสำคัญทางสถิติ ($p<0.05$) ผู้ป่วยที่มีค่าสมรรถภาพปอด FEV_1 น้อยกว่า 2 ลิตรหรือ ค่า FEV_1 FVC น้อยกว่าร้อยละ 70 ของค่าคาดคะเนมีความเสี่ยงต่อการเกิดภาวะแทรกซ้อนทั่วไปดังกล่าวแล้วข้างต้นเพิ่มกว่ากลุ่มที่มีค่ามากกว่าค่าดังกล่าวร้อยละ 30 ($p<0.05$) โดยไม่พบว่ามีค่าการตรวจสมรรถภาพปอดใดๆเลยที่มีความสัมพันธ์ทางสถิติกับการเกิดภาวะแทรกซ้อนต่อระบบทางเดินหายใจ

สรุป: จากการตรวจสมรรถภาพปอดด้วย spirometry ก่อนการผ่าตัดทรวงอก พบว่าผู้ป่วยที่มีค่า FEV_1 น้อยกว่า 2 ลิตร FEV_1 หรือ FVC น้อยกว่าร้อยละ 70 ของค่าคาดคะเนมีความสัมพันธ์กับการเกิดภาวะแทรกซ้อนทั่วไปหลังผ่าตัด

คำสำคัญ : การตรวจสมรรถภาพปอด, การพยากรณ์ภาวะแทรกซ้อน, การผ่าตัดทรวงอก

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