

Relationship Between the Result of Preoperative Pulmonary Function Test and Postoperative Pulmonary Complications*

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Good preoperative screening and evaluation of patients undergoing surgery is necessary because it serves to identify the individual who is at risk of increased intra-operative and postoperative morbidity and mortality. The retrospective study was done in an attempt to determine if abnormalities in preoperative pulmonary function, detected by routine pulmonary function tests, would predict which patients would suffer from pulmonary complications following surgery.

Pulmonary complications in the postoperative period included fever, atelectasis and respiratory failure. The overall incidence of pulmonary complications from our 78 patients undergoing surgery was 37 percent based on clinical criteria. This incidence was high in patients with FEV₁ less than 1.0 L/sec, MVV less than 40% of predicted value and PCO₂ more than 45 mmHg.

Key Words. *Pulmonary Function Test, Postoperative complication, FEV₁, MVV (Maximal Voluntary Ventilation), PCO₂, PO₂*

INTRODUCTION

The changes in medical practice that have taken place during the past decade have revolutionized and complicated the problems of medical consultation for surgical patients (Shoichet et al., 1983). The technological advance in diagnostic procedure and improvements in anesthetic practice permit surgery to be proposed with less limitation for the most of the patients. Physician, especially pulmonary physician, should have best knowledge, skill and judgement on pre- and postoperative care for the patients who might show possible complications.

The occurrence of respiratory complications following surgery usually depends on the existence of previous pulmonary disease (Herr, 1978; Tisi,

1979). Prior to surgery pulmonary disease may go unnoticed by the patient and unrecognized by the physician because of the tremendous reserve of the respiratory system. However major surgery and the effects of anesthesia are stressful to the pulmonary system (Herr, 1978).

Identification of patient at risk is not a difficult task if the predisposing factors associated with postoperative pulmonary complications are kept in mind.

The assessment of individual patients prior to surgery including exploratory thoracotomy or upper abdominal surgery usually includes objective measurement of pulmonary function. The retrospective study was done in an attempt to determine if abnormalities in preoperative pulmonary function test (PFT) would predict which patients would suffer from pulmonary complications following surgery.

MATERIALS AND METHODS

Data from 78 patients were collected during 6 month period from June to Dec. 1983, at the Severance Hospital, Yonsei University Medical Center.

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* *A part of this article was presented at the meeting of the 10th International Symposium on Respiratory Physiology and Lung Function Tests. June 12, 1984, Seoul, Korea.*

All patients underwent preoperative pulmonary function test before thoracotomy, upper abdominal surgery or other surgical procedure which requires general anesthesia.

Spirometry was performed using CFI 5000 with the patients in the standing position. Forced vital capacity (FVC), the forced expiratory volume at one second (FEV₁), maximal voluntary ventilation (MVV) and arterial PCO₂ were evaluated.

The incidence of postoperative pulmonary complications evaluated with chest X-ray films, body temperature and clinical symptoms were determined retrospectively.

RESULTS

Twenty nine patients (33%) showed various complications including fever, atelectasis and respiratory failure. There was no age preponderance. Table 1 illustrates FEV₁ and complication. Thirty three percent of fifty one patients with a FEV₁ more than 2 L suffered from various complications. And

twenty nine percent of 14 patients with FEV₁ from 1.5 to 2 L suffered from postoperative complication. And all patients with very low FEV₁ less than 1 L showed complications including respiratory arrest. Thirty one percent of the 65 patients with a MVV more than 50% of the predicted value suffered from postoperative complications. However those complications were very mild (Table 2). Table 3 illustrates the arterial PCO₂ level and complication rate. Our study revealed high complication rate in patients group with the high arterial PCO₂. Most of the patients showing high arterial PCO₂ seemed to have chronic obstructive lung disease and other underlying pulmonary disease. In addition to PaCO₂, PaO₂ was evaluated in 41 patients. One patient with a PaO₂ of less than 55 mmHg and 3 of 5 patients with a low PaO₂ (65–55 mmHg) showed postoperative complication (Table 4). Table 5 shows the relationship between the type of surgery and the rate of complication. The complication rate of thoracic surgery was higher than that of upper abdominal surgery. Table 6 lists the various complications we had observed in this study; they are fever, respiratory failure, atelectasis and 8 cases which required ICU care because of infection or abnormal arterial blood gas finding. Finally we would like to present a representative case who required of preoperative respiratory care for the purpose of prevention of postoperative complication. This 71 year old male patient was admitted to our hospital under the diagnosis of cancer of the colon. He had been suffered from dyspnea and chronic coughing. Preoperative PFT showed findings of severe obstructive ventilatory defect. He had been consulted to the medical department for the preoperative evaluation. We recommended that the patient should be under preoperative intensive respiratory care including antibiotic, bronchodilator and postural drainage. There was significant improvement in spirometric indices after respiratory care. Figure 1 illustrates PFT before and after the preoperative care. Miles'

Table 1. FEV₁ and complication

FEV ₁ (L/sec)	No. of pts	No. of complica- tion (%)
>2.0	51	17 (33)
2.0–1.5	14	4 (29)
1.5–1.0	8	3 (38)
1.0)	5	5 (100)

Table 2. MVV and complication

MVV* (%)	No. of pts	No. of complica- tions (%)
>50	65	20 (31)
50–40	4	2 (50)
40)	9	7 (78)

* % of predicted value

Table 3. PaCO₂ level and complication

P _a CO ₂ (mmHg)	No. of pts	No. of complica- tions (%)
>45	8	6 (75)
45–40	12	5 (42)
40)	50	3 (6)

Table 4. PaO₂ and complication

PaO ₂ (mmHg)	No. of pts	No. of complica- tions (%)
>75	23	5 (22)
75–65	12	7 (58)
65–55	5	3 (60)
55)	1	1

Table 5. Type of operation and complication

Type	No. of pts	No. of complications (%)
Upper abdominal surgery	39	7 (18)
Pneumonectomy	13	6 (46)
Lobectomy	13	8 (62)
Exploratory thoracotomy*	13	7 (54)

*including bullectomy

Table 6. Incidence of postoperative complications

Complications	No.
Fever	21
Respiratory failure	2
Atelectasis	2
Mild hypoxemia*	4
Total	29

* Need oxygen

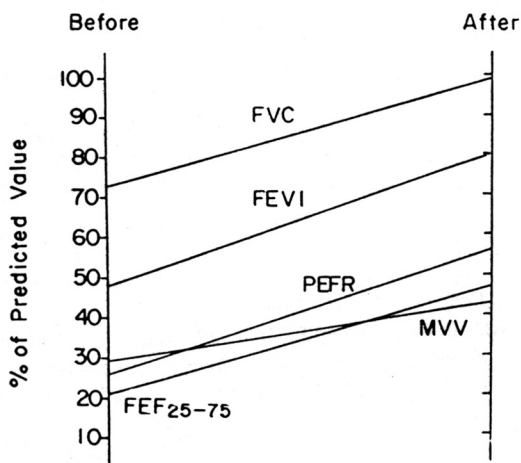


Fig 1. Improved parameters before and after respiratory care.

operation was done without any complication in this case.

DISCUSSION

Preoperative pulmonary evaluation would include precise history taking about respiratory symptoms and smoking history, and physical examinations. Laboratory examinations such as chest X-ray and EKG should be done. And finally PFT seemed to be one of the important test.

Anesthesia or surgical stress is associated with

significant depression in VC, FRC, and tidal volume as well as PaO_2 . And also defense mechanisms such as mucus clearance, cough and sigh are diminished. Stein and Cassara (1970) reported the range of minor to major complication would be 3 versus 70% of the operative patient with normal FEV_1 and abnormal FEV_1 respectively. Therefore it is very important to evaluate preoperative pulmonary function and incidence of complication. A number of methods for differential evaluation of pulmonary function exists including spirometry coupled with radionuclide tests (Wagner, 1976), lateral position pulmonary function testing (Hazlett and Watson, 1971; Walkup et al., 1980), radicespirometric tests, balloon occlusion tests, exercise testing, fluoroscopy, bronchoscopic respiratory gas sampling and intraoperative measurement of pulmonary arterial pressure (Demeester et al., 1974).

In this study, however, we tried to find the relationship between the essential preoperative values of routine spirometry and the incidence of complication.

Older and less reliable pulmonary function values that are indicative of high risk of postoperative cardiopulmonary complications are vital capacity less than 1 liter, FEV_1 less than 1 liter, $\text{FEF}_{25-75\%}$ less than 0.6 liter/sec, MVV less than 50 percent of predicted value, PaO_2 less than 55 mmHg and elevated preoperative PaCO_2 more than 45 mmHg. First of all there are no remarkable differences in complication by age in our study.

We evaluated the rate of complication according to the different level of FEV_1 . As most physician pointed out, this data revealed that low FEV_1 less than 1 liter showed the highest risk of postoperative complications. But there was no differences between the group of 2.0–1.5 L/sec and 1.5–1.0 L/sec. Patients with MVV less than 40% of predicted value showed the highest postoperative complication rate. Some authors emphasized that PaCO_2 level has very close relation to the postoperative complication. Our study revealed higher complication rate with higher PaCO_2 level. Usually high PaCO_2 suggested possible COPD or some underlying pulmonary disease (Burrows and Earle, 1969). In case with high PaCO_2 , we should search for the causes, and the patient should be under effective preoperative pulmonary care.

Sometimes PaO_2 level was not included for preoperative parameters in the evaluation of postoperative complication. However in this study postoperative complication rate was increased in the pa-

tient with lower PaO₂ level.

Impairment of voluntary effort due to sedation, post-anesthetic muscle fatigue and abdominal distension following surgery contribute to a general reduction in lung volume. The impairment is more severe following thoracic surgery (Kim *et al.*, 1972).

In spite of 18% of the 38 patients who underwent upper abdominal surgery experienced some minor complication, 46 to 62% of the patients who underwent thoracic surgery has been suffered from various complications. However there was no remarkable differences in incidence of complications between lobectomy, pneumonectomy and exploratory thoracotomy.

The overall incidence of pulmonary complications in the surgical patient approximates 5 to 10 percent based on clinical criteria in general. In our study, the complication rate of 37 percent is somewhat higher than that of other reports because our data included minor complication such as fever.

Anesthesia and surgery caused pulmonary insufficiency most commonly by reducing lung volumes. To reduce pulmonary complication we have to carefully assess preoperative pulmonary function tests and apply various postoperative respiratory care (Jung *et al.*, 1980; Ali *et al.*, 1984; Bartlett *et al.*, 1973). In addition to this study, we would try prospective study for further precise relation between preoperative pulmonary function tests and postoperative complications.

ACKNOWLEDGEMENTS

We are grateful to Miss Aeran Ahn for her assistance in preparing this data and we also thank Miss Younghee Kim for her secretarial work.

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