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Clinical Study on Postopertive Pulmonary Complication after Resection for Lung Cancer with Impaired Pulmonary Function

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Introduction

Recently, surgical procedures for lung cancer are being applied increasingly for those cases with poor pulmonary function, according to the increasing population of senile people and advancement in the pre-and postoperative care. Elderly patients of lung cancer were found to show high ratio in these dysfunctions, and many patients suffer from postoperative complications such as atelectasis, pneumonia and prolonged pulmonary air leakage. Also, there seems to be a number of patients who develop respiratory insufficiency caused by these pulmonary complications. This time, we have analyzed the postoperative processes of the cases with pre-operative $FEV_{1.0}$% less than 55%, and have gained some findings. We hereby report about it.

Patients and Methods

Among 216 cases with the resection for lung cancer performed in our division from January 1987 to March 1992, twenty cases (9.2%) with pre-operative $FEV_{1.0}$% less than 55% were subjected. And addition of neophiline was performed in the cases with complication of asthma and, as a general rule, the highest value was used after the three-times determination. In these cases, every patient had difficulty in expectoration postoperatively. We classified these cases into two groups, and one is those eight cases in which ICU period continued beyond seven days requiring one to eleven days of treatment with artificial respiration (Group I with severe postoperative pulmonary complications). The other group is those twelve cases in which expectoration treatment was performed under the observation with bronchoscopy and thus they could overcome the early postoperative complications (Group II with light postoperative pulmonary complications). And thus, we have studied their clinical symptoms and examined the relation between the pre-operative parameters of the ventilatory function and the postoperative pulmonary complications.

Results

The ages of these twenty cases ranged from sixty-six to eighty years (average, seventy-two years old). As for the sex, 19 males and one female. All the patients had the smoking habits (Brinkman Index 500-2000). Preoperative chest x-ray photographs revealed seventeen cases of the peripheral type, and three cases of the central type, thus showing many cases to be peripheral lung cancer. Preoperatibe ventilatory function showed that $FEV_{1.0}$% was 46.5 ± 8.5%, $FEV_{1.0}$ was 1180 ± 354ml, $\dot{M}MF$ was 0.44 ± 0.2L/sec., $FEV_{1.0}$/p-VC was 32.8 ± 11%, V_{50} was 0.58 ± 0.2L/sec., RV/TLC was 51.8 ± 8.7%, thus showing poor ventilatory function. They met the severe diagnostic standards of less than 55% of $FEV_{1.0}$%, more than 150% of RV and more than 45% of RV/TLC in evaluation of pulmonary function in the chronic pulmonary emphysema cases by the Pulmonary Emphysema Study Association. The histological type was found to be classified into as follows: nine cases of squamous cell carcinoma, seven cases of adenocarcinoma, three cases of large cell carcinoma and one case of small cell carcinoma, and the following surgical procedures were performed: lobectomies including one sleeve procedure in sixteen cases, segmentectomy in one case, wedge resections in two cases and completion pneumonectomy performed in one case for the anastomotic stenosis which occurred after sleeve procedure. The postoperative stage was classified as follows; twelve cases in the first stage, two cases in the second stage, five cases in the third stage and one case in the fourth stage. When the pre-operative parameters of Group I and Group II were classified respectively, they were as follows: as for the Group I, $FEV_{1.0}$% was 41.9% ± 7.8%, $FEV_{1.0}$ was 858 ± 206ml, $\dot{M}MF$ was 0.2 ± 0.07L/sec., $FEV_{1.0}$/p-VC was 27.6 ± 6.8%, V_{50} was 0.38 ± 0.09L/sec, and RV/TLC was 51.9 ± 6.8%. As for the Group II, $FEV_{1.0}$% was 49.7 ± 7.6%,

$FEV_{1.0}$ was 1395 ± 252ml, MMF was 0.54 ± 0.19L/sec., $FEV_{1.0}$/p-VC was 45.2 ± 7.5, $\dot{V}_{50}$ was 0.58 ± 0.24L/sec., RV/TLC was 48.9 ± 2.3%. Thus, significant difference of $P < 0.05$ was noticed between the two groups concerning $FEV_{1.0}$, MMF, $FEV_{1.0}$/p-VC (Table 1). And, in order to calculate the averaged value, t-test was performed. Also, in order to determine the significant differences of the ratio, χ^2-test was performed.

Table 1. Pre-operative pulmonary function of Groups I and II

Pre-operative Parameter	Group I (n = 8)	Group II (n = 12)
$FEV_{1.0}$% (%)	41.9 ± 7.8	49.7 ± 7.56
$FEV_{1.0}$ (ml)	858 ± 206*	1395 ± 252
MMF (L/sec.)	0.28 ± 0.07*	0.54 ± 0.19
$FEV_{1.0}$/p-VC (%)	27.6 ± 6.8*	45.2 ± 7.5
$\dot{V}_{50}$ (L/sec.)	0.38 ± 0.09	0.58 ± 0.24
RV/TLC (%)	59.1 ± 6.8	48.9 ± 2.3

*Significantly different from Group II ($P < 0.05$)

In the eight cases of Group I (Table 2), the age ranged from sixty-two to seventy-four years old, the smoking habit indeces were 400-1600, and surgical procedures of more than lobectomies were performed, except which was found to be one wet case (Case 3). Concerning the postoperative pulmonary complications, cases can be classified as follows: three cases of respiratory insufficiency caused by the prolonged pulmonary air leakage, two cases of hypoxemia caused by expansion insufficiency of the lung, two cases of pneumonia and one case of hypercapnea induced by the prolonged pulmonary air leakage, thus, many complications were shown to be caused and derived from the prolonged pulmonary air leakage. However, postoperative intensive care made it possible to recover and gain the remission from the early postoperative complication in all cases. Case 6 revealed 580ml of $FEV_{1.0}$, the poorest function of the lung in the whole cases of this study, and the right lower lobectomy was performed against the large cell carcinoma of the right lung S^6 (Fig. 1). In this case, hypoxemia occurred postoperatively due to expansion insufficiency of the lung and the patient required the treatment with artificial respiration for eleven days. However, the patient has been cured of the postoperative respiratory symptoms by intensive care. In the twelve cases of Group II (Table 3), the ages ranged from sixty-five to eighty years. The Brinkman indeces were found to be 300-2000. In one case with complication of renal dysfunction and an eighty-year-old patient, only wedge resection of the lung was performed. However, radical resection for lung cancer was performed together with mediastinal lymphnode dissection in other eleven cases. In these cases, although all the patients complained the difficulty in expectoration of sputum, it was possible for them all to be cured after one to eighty times (averaged number of 3.4 times) of repeated expectoration treatment with bronchoscopy, thus enduring and overcoming the postoperative respiratory symptoms. We tried analyses and summing up of parameters ($FEV_{1.0}$, MMF, $FEV_{1.0}$/pVC) about which significant differences are shown between the Group I and II as described in Figures. And then, it was found that the whole cases could be classified in the Group I when they were at less than 1000ml of $FEV_{1.0}$. Concerning the value of $FEV_{1.0}$/p-VC,

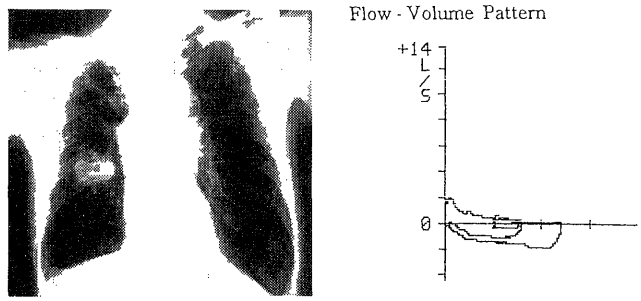

Fig. 1. Pre-operative Chest X-ray photograph and Flow-Volume Pattern in Case 6

Table 2. Characteristics of Group I

Case	Age•Sex	Treatment	Histology	Stage	Complication	Prognosis
1	68•M	C. Pneumonec.*	Sq	I	Res. fail.***	38M dead
2	74•M	Lobectomy	Sq	I	Pneunonia	48M alive
3	71•M	Wedge R.**	Ad	IV	Res. fail.***	13M dead
4	75•M	Lobectomy	Ad	I	Pneunonia	18M alive
5	75•M	Lobectomy	Ad	I	Hypoxemia	20M alive
6	71•M	Lobectomy	Large	I	Res. fail.***	36M alive
7	62•M	Lobectomy	Ad	IIIa	Hypercapnea	14M alive
8	69•M	Lobectomy	Sq	IIIa	Hypoxemia	48M alive

*Completion Pneumonectomy
**Wedge Resection
***Respiratory failure

Table 3. Characteristics of Group II

Case	Age•Sex	Treatment	Histology	Stage	Complication	Prognosis
9	69•M	Lobectomy	small	I	(–) ***	12M alive
10	73•M	Seg.*	Ad	I	(–) ***	52M alive
11	69•M	Lobectomy	Sq	I	(–) ***	26M dead
12	80•M	Wedge R.**	Sq	II	(–) ***	18M dead
13	65•M	Lobectomy	Ad	IIIa	(–) ***	11M alive
14	73•M	Lobectomy	Ad	I	(–) ***	19M alive
15	72•M	Lobectomy	Large	I	(–) ***	20M alive
16	72•M	Lobectomy	Sq	I	(–) ***	13M dead
17	72•M	Lobectomy	Large	I	(–) ***	10M alive
18	75•F	Lobectomy	Sq	IIIa	(–) ***	18M alive
19	68•M	Lobectomy	Sq	IIIa	(–) ***	19M alive
20	66•M	Lobectomy	Sq	II	(–) ***	38M alive

*Segmentectomy
**Wedge resection
***Difficulty in expectoration

only one case was shown to be of more than 35% in the Group I, and other eleven cases were classified in the Group II. Concerning MMF, all the cases with more than 0.4 of MMF were recognized to belong to the group whose postoperative pulmonary complications were rather light (Fig. 2).

Discussion

According to the increasing occurrences of lung cancer, we are having more and more cases requiring operations of lung cancer complicated with impaired pulmonary function due to the increased ages and smoking habits, in particular, complicated with obstructive ventiltory disorders. Among the postoperative complications of the lung cancer, acute postoperative atelectasis and pneumonia are frequent even in the cases with normal polmonary function. However, in many cases, they have often been cured by the expectoration treatment using postoperative bronchoscopy once or twice without causing severe pulmonary complications because of the advancement and spread of postoperative airway cleaning developed with the bronchoscopy and trahelper. However, in the cases with obstructive ventilatory disorder, there may occur frequently the cases requiring daily expectoration treatment under the bronchoscopy for more than one week. Because radical treatment is demanded in the surgical procedures for the lung cancer, the resection of the mediastinal lymphnodes addition to lobectomy is assumed to be necessary and could be the typical surgical procedure. Therefore, it seems that damage of the vagal nerves was caused by the resection of mediastinal lymphnodes[1] and/or interruption of the bronchial arteries,[2] both of which could cause expectoration

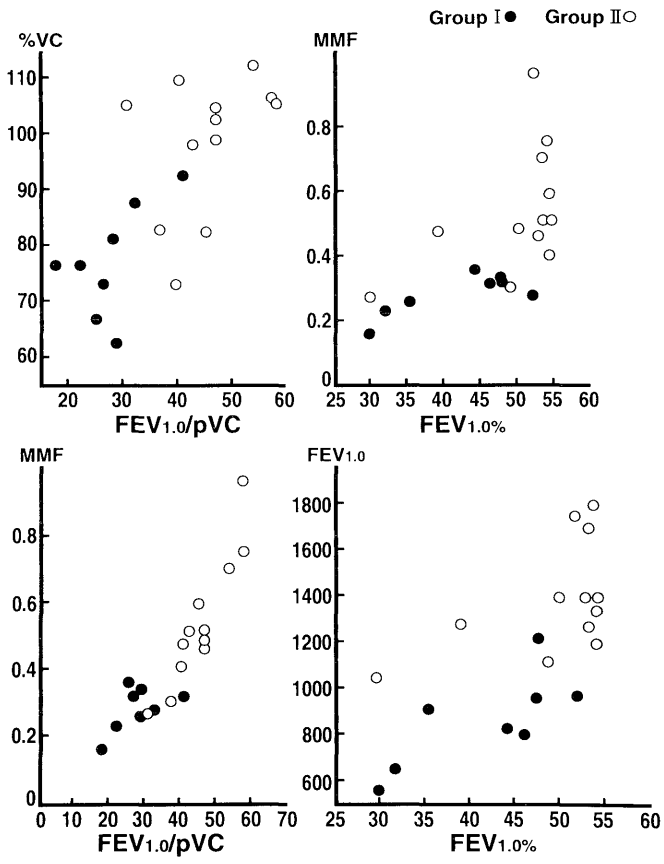

Fig. 2. Rerationship between Group I and Group II with preoperative parameters

insufficiency. In the cases of lung cancer complicated with the obstructive ventilatory disorders, the peripheral types of lung cancer occur frequently,[3] and of our twenty cases,

seventeen cases were peripheral types of ling cancer. For these lesions it is still being debated which method should be taken; the radical operation for lung cancer in addition to the resection of the mediastinal lymphnode, or only the limited operation. In our cases, limited operations were performed only in two cases of eighty-year-old patient with decreased renal function and the other in a wet case. For other eighteen cases, the radical operation for lung cancer has been performed together with the mediastinal lymph-node dessection.

It could be said whether the postoperative pulmonary complications would be caused of not, depending on whether the patient could perform expectoration adequately or not. Therefore, the most important factor related to the occurrences of the postoperative pulmonary complications would depend upon whether the patient can do adequate expectoration and the expectoration quantity is enough, or not.

The decreased expectoration of the sputum is frequently caused by the decrease of $FEV_{1.0}$, as well as the respiratory muscle weakness caused by emanciation, aging or sever pain in the wound. Koide[4] reported that among the cases with FEV 1.0% less than 55% shown and with surgical resection of the lung cancer performed and thereafter complicated with obstructive ventilatory desorders, they had performed the radical resection of lung cancer for thirty-two cases with less than 1000ml/M^2 of $FEV_{1.0}$. And then, the postoperative pulmonary complications occurred in fourteen cases of these 32 cases and most of them had difficulty in expectoration of sputum. They also performed the surgical procedures without resection of the mediastinal lymphnodes (R0 or R1) or the limited operation in these cases, because they had assumed that these patients might cause quite frequently the pulmonary complications if the radical operations for lung cancer were performed. The preoperative ventilatory function had made them consider and decide to perform the above-mentioned treatment. They reported that among these nine cases with limited operations pulmonary complication occurred only in one case. Also, Olsen et al.[5] reported that in their cases, those showing pre-operatively less than 800ml of $FEV_{1.0}$ presented the postoperative symptoms of hypercapnea, falling into the condition of respiratory insufficiency. Also, Yuasa et al.[6] reported that their study of sixty-five cases with less than 1500ml of pre-operative $FEV_{1.0}$ had revealed the fact that significant insufficiency of expectoration would frequently occur in those cases showing preoperatively less $FEV_{1.0}$ and they surely required the artificial respiration. Thus, concerning the postoperative pulmonary complications, there seems to be many reports[7,8,9] which suggested and pointed out the importance of relation to $FEV_{1.0}$ rather than the relation to $FEV_{1.0}$%. Also, in our cases, it was recognized that severe postoperative pulmonary complications were caused in all cases with less than 1000ml of $FEV_{1.0}$. Moreover, it seems that MMF could be used as the index of obstruction in the peripheral airway, and it could be said to be a simple and concise type of flow volume curve or closing volume and thus used also as the index of ventilatomy function because of its characteristics of easiness to perform. There have been fewer reports[10] of MMF up to present so far, but among our cases, it was shown to be less than 0.4l/sec MMF in the cases with severe postoperative pulmonary complications. There have been some reports[11] which said that $FEV_{1.0}$/p-VC could be used as a risk factor to predict the postoperative pulmonary complications, and Nakahara et al,[12] also reported that the value of more than 40% of $FEV_{1.0}$/p-VC could be regarded as the safety limits.

When we studied the clinical symptoms of postoperative pulmonary complications, it was recognized that there occur many cases caused by prolonged pulmonary air leakage, therefore subcutaneous emphysema would be frequently induced and then would reach insufficiency of the lung expansion, resulting in the occurrence of atelectasis and pneumonia, and hypoxemia and hypercapnea would be resulted. The lungs in the senile people tend to cause emphysema, and because of their fragile characteristics, postoperative air leakage may continue and this would result in the difficulty in postoperative care and treatment because of the pains and aches caused by the long-time use of the thoracic drainage. In order to make the postoperative care and treatment much easier, prevention of air leakage seems to be important, and obviously it requires to endeavour in recovering the damage of the lung by applying fibrin glue or mechanic suturings. In spite of these procedures and treatments re-operation should be tried, if air leak still continues for a long time, even though the patient is senile.

Recently, there appear the reports[13,14] which say that forecast of the postoperative pulmonary complications was possible because scintigram of the ventilation-perfusion made it possible to predict postoperative pulmonary function and this seems quite useful for the prevention of postoperative insufficiency of the heart and lung functions. However, this does not always coincide accurately with the predicted postoperative values in the cases of pulmonary emphysema complicated with obstructive ventilatory disorders because of the inequalities of ventilation-perfusion ratio, respiratory muscle weekness and the change of the pulmonary parenchyma caused by the imbalance between the thorax and the pulmonary volume. It seems to be important to analyse the pre-operative ventilatory function in order to predict the postoperative pulmonary complications.

Conclusion

1) No operative death occurred even in the cases with $FEV_{1.0}$% only less than 55%, and the postoperative inten-

sive care made it possible for all the patients to overcome the early postoperative complications.

2) In these cases, there occurred frequently the complications caused by the prolonged pulmonary air leakage. It would be urgently required to establish measures against the air leak by using intra-operatively the fibrin glue or automatic suturing machines.

3) It was possible to perform operations fairly salely when the following values were shown: more than 1000ml of $FEV_{1.0}$, more than 0.4L/sec, of MMF and more than 35% of $FEV_{1.0}$/p-VC.

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