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Effective preoperative and postoperative respiratory training in a lung cancer patient with chronic respiratory failure.

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Abstract

A case illustrating the value of aggressive respiratory training in improving the prognosis of lung cancer complicated by low pulmonary function is reported. Preoperative and postoperative respiratory training enabled the patient with chronic respiratory failure to survive a lengthy operation and eventually breathe without assistance. The patient has survived more than 71 months, and experiences only exertional dyspnea at the time of publication. Aggressive preoperative and postoperative respiratory management may make more of the growing number of lung cancer patients eligible for standard surgical procedures.

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— Brief Note —

Effective Preoperative and Postoperative Respiratory Training in a Lung Cancer Patient with Chronic Respiratory Failure

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A case illustrating the value of aggressive respiratory training in improving the prognosis of lung cancer complicated by low pulmonary function is reported. Preoperative and postoperative respiratory training enabled the patient with chronic respiratory failure to survive a lengthy operation and eventually breathe without assistance. The patient has survived more than 71 months, and experiences only exertional dyspnea at the time of publication. Aggressive preoperative and postoperative respiratory management may make more of the growing number of lung cancer patients eligible for standard surgical procedures.

Key words : **lung cancer, low pulmonary function, respiratory training**

Several studies (1-4) have focused on the surgical indications and selection of appropriate surgical methods for lung cancer patients complicated by low pulmonary function. However, it is frequently necessary to resort to standard surgery even in patients with low pulmonary function in combination with aggressive respiratory training and prudent respiratory management before and after surgery.

Case Report

A 72-year-old man was admitted to our hospital, for further evaluation after an abnormal shadow appeared on a chest roentgenogram taken during a mass screening examination in June 1985. He was a heavy smoker, and lung cancer was suspected.

Physical examination on admission revealed that respiratory and heart sounds were normal. Performance status was Hugh-Jones class II. Laboratory examinations revealed no abnormalities in peripheral blood, blood chemistry or urinalysis. As for tumor markers, CEA showed an increased value of 7.9 ng/ml. On chest roentgenograms (Fig. 1) and computed tomography (CT) images (Fig. 2) a 3×3 cm mass shadow was present in the left S^3 region. A bronchofiberscopic examination of the trans-bronchial lung biopsy of the left S^3 lesion revealed squamous metaplasia.

Preoperative pulmonary function tests were performed. Results of % FVC (forced vital capacity) 59 %, $FEV_{1.0}$ % (forced expiratory volume in one second to forced vital capacity ratio) 72 % and % DLco (CO diffusing capacity) 64 % indicated restrictive and diffusion disturbances. Parameters of respiratory muscle strength were MIP (maximal inspiratory pressure) 87 cmH_2O (normal range: 77.4-127.4 cmH_2O) and MEP (maximal expiratory pressure) 120 cmH_2O (normal range: 105.1-181.3 cmH_2O). Results of arterial blood gas analysis were Po_2 (arterial oxygen tension) 53.3 mmHg and Pco_2 (arterial carbon dioxide tension) 47.9 mmHg, indicating chronic respiratory failure. Postoperative pulmonary function was predicted by pulmonary perfusion scintigraphy. The results predicted in the case of left upper lobectomy were FVC 1.46 L and $FEV_{1.0}$ 1.05 L. These values represented the minimum values at which left upper lobectomy would be tolerated.

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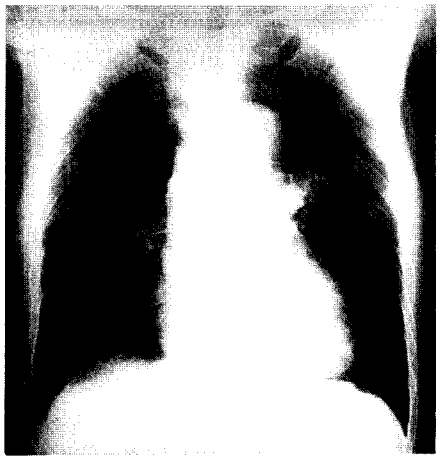

Fig. 1 Chest roentgenogram demonstrating a tumor shadow in the left hilum.

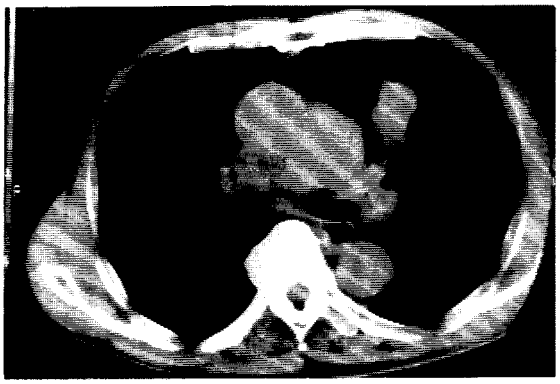

Fig. 2 Chest CT image at level of subcarina demonstrating a tumor shadow with irregular shape and homogenous content in the left S^3.

A lymphadenectomy and lobectomy of the upper lobe of the left lung was performed on October 30, 1985 under general anesthesia. The pathological diagnosis was squamous cell carcinoma (T1NOMO, Stage I). The operation took 3 h 30 min, with no complications.

Postoperative course is summarized in Table 1 and Fig. 3. Weaning was attempted gradually, but extubation was postponed because spontaneous ventilation was inadequate and frequent aspiration of sputum was necessary owing to markedly increased sputum production. Tracheostomy was performed on the 7 th postoperative day. At 1 month after the operation, pulmonary function was FVC 1.03 L, $FEV_{1.0}$ 0.61 L, TV (tidal volume) 0.44 L and MIP 75 cmH_2O. With the ventilator set to FIo_2 (inspired oxygen concentration) 0.4, CPAP (continuous positive airway pressure) 5 cmH_2O and IMV (intermittent mandatory ventiration) 4/min, Pco_2 and Po_2 were 64.9 mmHg and 56.3 mmHg, respectively. Respiratory training was started and pulmonary function gradually improved until unassisted breathing became sustainable. The patient was discharged 4 months after the operation. The patient complained of moderate dyspnea after discharge but was able to conduct daily activities at home. At present, approximately 71 months after the operation, the severity of the dyspnea has increased slightly and the administration of oxygen is occasionally necessary. However, there has been no evidence of recurrence on roentgenograms of the chest (Fig. 4).

Training procedure. Respiratory training was performed before and after the operation using incentive spirometry. Preoperative respiratory training was performed for 4 weeks. Postoperative respiratory training was performed from one month after the operation. In order to provide postoperative respiratory training, oxygen administration using a humidifier was the only therapy used, and was applied for 1 h, 3 times a day during the daylight hours. During these training periods, the incentive spirometry was connected via a one-way value to the tracheostomy cannula every 20 min, as shown in Fig. 5.

Training results. Changes in pulmonary function before and after the 4-week preoperative respiratory training are shown in Table 1. No significant changes occurred in FVC and $FEV_{1.0}$. However, MVV (maximal voluntary ventilation) and MIP improved as did DLco.

Change in pulmonary function after postoperative respiratory training were shown in Table 1 and Fig. 3. It was possible to withdraw the SIMV (synchronized IMV) on the 54 th postoperative day. Sputum production decreased and pulmonary function gradually improved after the initiation of the respiratory training. At 2 months after the operation, pulmonary function improved to FVC 1.21 L, $FEV_{1.0}$ 0.75 L, and MIP 98 cmH_2O. Respiratory training was continued, CPAP was completely withdrawn, and the amount of oxygen administration was gradually decreased. Pulmonary function at discharge was FVC 1.40 L and $FEV_{1.0}$ 0.95 L. Results of arterial blood gas analysis were Pco_2 44.0 mmHg and Po_2 57.8 mmHg. Performance status at discharge was Hugh-Jones class III.

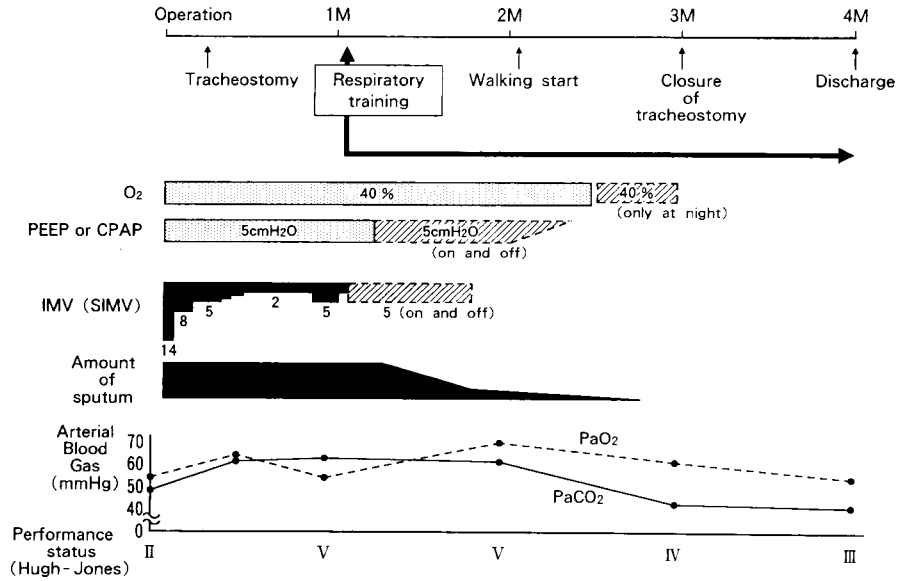

Fig. 3 Postoperative clinical course.

Table 1 Preoperative and postoperative pulmonary function test values

Pulmonary function test	Test values						
	Preoperative			Postoperative (month)[a]			
	Before training	After training	Predicted	1	2	3	4
FVC (l)	1.90	2.00	1.54	1.03	1.21	1.37	1.40
% FVC	59	62	48	32	38	43	43
$FEV_{1.0}$	1.37	1.40	1.08	0.61	0.75	0.83	0.95
$FEV_{1.0\%}$	72	70	70	59	64	61	68
TV (ml)	443			440	450	400	430
MVV (l)	41.0	50.2	38.7				31.6
% MVV	44	54	41				34
DLco (ml/m/mmHg)	14.8	16.0					
MIP (cmH_2O)	87	103		75	98	90	93
MEP (cmH_2O)	120	128			109	109	106
pH	7.382	7.363		7.363	7.341	7.419	7.457
Pco_2 (mmHg)	47.9	53.9		64.9	64.4	45.7	44.0
Po_2 (mmHg)	53.3	53.1		56.3	73.6	64.0	57.8
HCO_3 (mmol/l)	28.5	30.7		33.7	34.8	29.6	31.1
BE (mmol/l)	3.0	4.0		6.2	7.5	4.9	7.2
O_2SAT (%)	87.6	86.7		86.0	93.5	93.1	91.4

Pulmonary function demonstrates chronic respiratory failure. Pulmonary function, especially maximal inspiratory pressure (MIP), was improved by the 4-week respiratory training. *a*: 1 and 2 months after the operation, each test was done during 40 % O_2 inhalation.

FVC: forced vital capacity; $FEV_{1.0\%}$: forced expiratory volume in 1 sec to forced vital capacity ratio; TV: tidal volume; MVV: maximal voluntary ventilation; DLco; CO diffusing capacity; MEP: maximal expiratory pressure; Pco_2: arterial carbon dioxide tension; Po_2: arterial oxygen tension; HCO_3: bicarbonate; BE: base excess; O_2SAT: oxygen saturation.

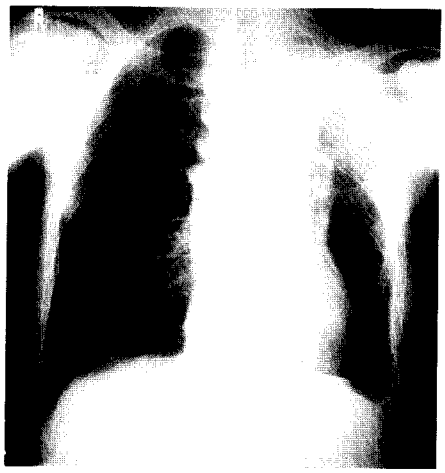

Fig. 4 Chest roentgenogram obtained 71 months after operation. No evidence of recurrence was demonstrated.

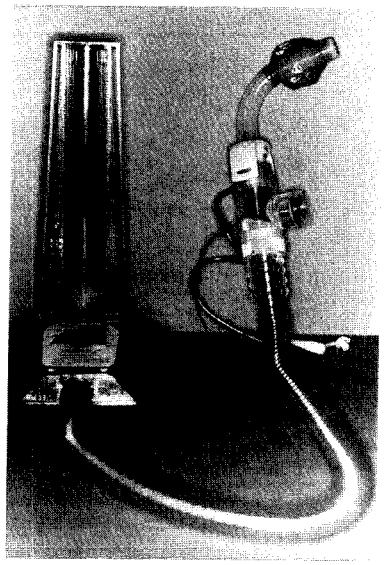

Fig. 5 Incentive spirometry used for respiratory training. The training was performed by connecting the incentive spirometry to the tracheostomy cannula, placing a one-way valve between.

Discussion

It is necessary to consider pulmonary function and performance status in addition to histologic type and staging of lung cancer to decide the surgical indications for lung cancer cases. Several methods to evaluate pulmonary function (1-4) and cardiopulmonary function (5) have been studied and are available for this decision-making process. In general, limited operation or therapeutic interventions other than surgical therapy are selected in cases with low pulmonary function. Hewever, the prognoses tend to be poorer than those cases with more standard surgical procedures and little can be expected from chemotherapy and radiation therapy. This leads to the proposition that standard surgical procedures may be performed after providing respiratory training for a given period, and then performing aggressive postoperative respiratory training in patients with low pulmonary function.

There have been many reports (6-8) describing patients with chronic obstructive pulmonary disease who were able to increase muscle strength and maximum exercise capacity by inspiratory muscle endurance training. We previously reported that preoperative respiratory training using incentive spirometry improves respiratory muscle strength and helps prevent the formation of microatelectasis (4, 9). Ordinarily maximal respiratory pressure (MIP and MEP) is used as an index of respiratory muscle strength. MIP has been reported to return to 92.8 % of the preoperative value about 1 month after surgery in lung cancer patients (9). In the present case, incentive spirometry was effective in the weaning process from mechanical ventilation. Respiratory muscle strength was improved by postoperative respiratory training, while FVC and $FEV_{1.0}$ recovered as expected. This case is valuable in that it illustrates the possibility of performing surgery in cases in which surgery would ordinarily considered intolerable to the patient by first conducting aggressive respiratory training and careful respiratory management.

References

1. Olsen GN, Block AJ and Tobias AJ: Prediction of post-pneumonectomy pulmonary function using quantitative macroaggregate lung scanning. Chest (1974) **66**, 13-16.
2. Ali MK, Mountain CF, Ewer MS, Johnston D and Hayanie TP: Predicting loss of pulmonary function after pulmonary resection for bronchogenic carcinoma. Chest (1980) **77**, 337-342.
3. Konishi H: Prediction of postoperative respiratory function of lung cancer patients using quantitative lung scans. J Jpn Assoc Thorac Surg (1982) **30**, 1784-1795 (in Japanese).
4. Hara H, Konishi H, Kanetou S, Yamamoto S, Watanabe T, Kurita A, Kunikata E, Shimizu N and Teramoto S: Clinical evaluation of regional pulmonary function in lung cancer patients using quantitative lung scan. J Jpn Thorac Surg (1984) **32**, 1184-1193 (in Japanese).
5. Olsen Gn, Bolton JWR, Gas GD, Maclain WC, Schoonover GA and

Hornung CA: Submaximal invasive exercise testing and quantitative lung scanning in the evaluation for tolerance of lung resection. Chest (1989) **95**, 267-273.

6. Leith DE and Bradley M: Ventilatory muscle strength and endurance training. J Appl Physiol (1976) **41**, 508-516.
7. Sonne LJ and Davis JA: Increased exercise performance in patients with COPD following inspiratory resistive training. Chest (1982) **81**, 436-439.
8. Chen H, Dukes R and Martin BJ: Inspiratory muscle training in patients with chronic obstructive pulmonary disease. Am Rev Respir Dis (1985) **131**, 251-255.
9. Andou A: Clinical study of respiratory muscle strength in lung cancer patients. Okayama Igakkai Zassi (1987) **99**, 987-1001 (in Japanese).

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