

Fiberoptic Evaluation of Peripheral Airways of Two Patients with Acute Respiratory Failure during Mechanical Ventilation

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Fiberoptic bronchoscopy is an useful examinations to evaluate the patient's airway in intensive care unit because this technique is relatively non-invasive and can be repeated. A conventional fiberoptic bronchoscope, however, is too large in diameter to observe the peripheral airways.

Recent technological development in fiberoptic bronchoscope has enabled us to observe more peripheral airways. To evaluate the changes and the courses of the peripheral airways of acute respiratory failure during mechanical ventilation, we observed the peripheral airways by using a fiberscope of 1.8 mm outer diameter (BF-1.8T; Olympus) in two patients who needed artificial ventilation due to acute respiratory failure. Patients were informed of the study before the examination.

Case Report

Case 1

Seventy years old female was admitted to our hospital for esophageal can-

cer. She had dysphagia and vomiting for three months prior to admission. Respiratory function test showed %VC of 122% and FEV_{1%} of 78%. Arterial blood gas analysis was pH 7.45, PaCO₂ 34.6 torr, and PaO₂ 87 torr at room air. Chest X-ray film and other laboratory data revealed no abnormalities, except slight increase in GOT (38 IU·l⁻¹) and GPT (51 IU·l⁻¹). She had a history of hypertension and antihypertensive drugs were prescribed for five years.

After the esophagectomy, she could not weaned from mechanical ventilatory support due to hypoxia with bilateral pleural effusion. On ninth postoperative day, chest X-ray film showed perivascular cuffings, obliteration of left hemidiaphragm, and consolidative density behind the heart. PaO₂ was 108 torr at F_IO₂ 0.6 and 8 cmH₂O of PEEP.

In order to prevent hypoxia during bronchoscopy, the patient was ventilated pure oxygen. The bronchoscope was inserted via a Swivel connector (Swivel Y; Sontek Medical Inc.), between the ventilator circuit and the endotracheal tube. Disconnecting the ventilator or changing the ventilator settings was not required. Oxygen saturation was monitored by a pulse

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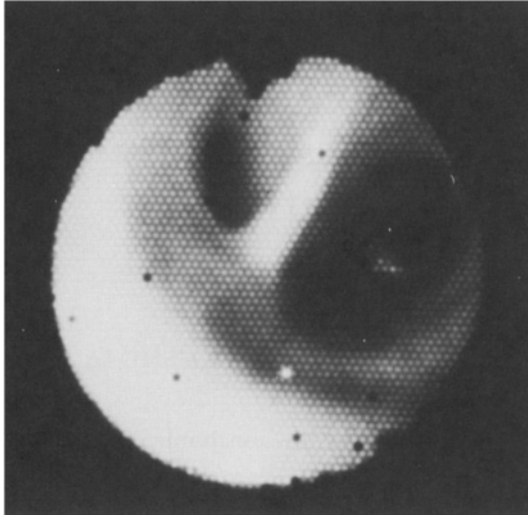


Fig. 1. Peripheral airway picture of fiberoscopy by the BF-1.8T at 9th day of the mechanical ventilation of the case 1. Chest X-ray film showed perivascular cuffings, obliteration of left hemidiaphragma and consolidative density behind the heart. Fiberoscopy revealed mild secretion and pigmentation, but no ectasis and pallor.

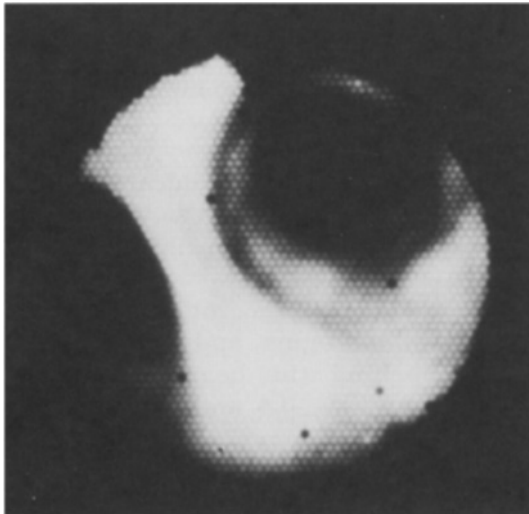


Fig. 2. Fiberoscopy at 16th day of the mechanical ventilation of the case 1. Although there was a clearing of perivascular cuffings on chest X-ray film, ectasis and mild pallor were identified in fiberoscopy.

oxymeter throughout bronchoscopy.

Examination of peripheral airways

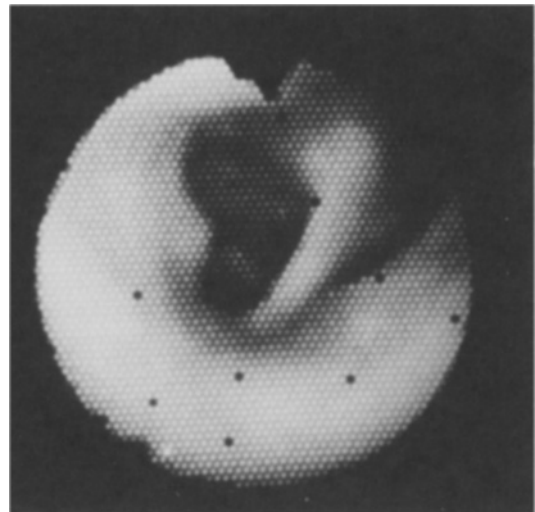


Fig. 3. Fiberoscopy at 23th day of the mechanical ventilation of the case 1. Chest X-ray film showed a hyperlucency of bilateral upper lobes but did not demonstrate remarkable changes. Ectasis and pallor developed and secretion, stenosis and swelling were found in the peripheral airways.

by the BF-1.8T showed mild secretion and pigmentation (fig. 1). One week later, 16th postoperative day, ectasis and mild pale changes as well as pigmentation of peripheral airway wall were identified by fiberoscopy (fig. 2) in spite of improvement on the chest X-ray film. On 23th day, PaO_2 was improved to 97 torr with FI_{O_2} 0.45 and 4 cmH_2O of PEEP. Chest X-ray film demonstrated no changes except a hyperlucency of bilateral upper lobe compared with that on 16th day. However, ectasis and pallor in peripheral airways became prominent, and stenosis and secretion were also found sporadically (fig. 3). Two days later she was successfully weaned from ventilator.

Case 2

Sixty eight years old man, who had no history of respiratory disease, underwent right maxillectomy due to the maxillary cancer. On second postoperative day, he developed hypoxia (PaO_2

58.6 torr at FI_{O_2} 0.5) and revealed bilateral diffuse infiltrative densities on chest X-ray film, possibly due to aspiration of bloody secretion from surgical wound. His lung was mechanically ventilated with FI_{O_2} 0.6, tidal volume 500 ml, IMV 5/min, and PEEP 5 cmH_2O . One week later, diffuse abnormal shadow became worse at bilateral middle and lower lung fields with fever up to 39°C. Arterial blood gas analysis showed Pa_{O_2} 90 torr and Pa_{CO_2} 45.7 torr, when the ventilator setting was FI_{O_2} 0.6 and tidal volume 600 ml with 5 cmH_2O of PEEP. Bronchoscopy by the BF-1.8T, which was performed in the same manner of Case 1, showed mild ectasis of peripheral airway wall and pallor of mucosa. Two weeks after the initiation of mechanical ventilation, chest X-ray film showed significant improvement in the lung lesion. FI_{O_2} was reduced to 0.5, and Pa_{O_2} increased to 148 torr. However, dilatation and pallor of peripheral airways became more prominent in comparison with the initial findings. On 18th postoperative day, he was successfully weaned from artificial ventilation.

Discussion

Details and characteristic features of fiberscope of the BF-1.8T which was used for observation of the peripheral airways have been described elsewhere¹. Briefly, outer diameter of the fiberscope is 1.8 mm, which enables observation of bronchi 2 mm or less in diameter. It cannot change the direction actively and aspirate secretion because it does not have a direction control device and a suction channel. Clinical usefulness of the BF-1.8T has been reported by Tanaka and colleagues in patients with chronic lung diseases².

Although we inserted the fiberscope blindly, we confirmed by the chest X-ray films and computed tomographies that tip of the BF-1.8T fiberscope was

located in the right lower lobe and close to the diaphragmatic pleura in most cases. Tanaka and his colleagues¹ described that the BF-1.8T could reach to the tenth to thirteenth generation of bronchial dichotomy.

Pigmentation, ectasis and pale color change of peripheral airways were observed by fiberscopy during mechanical ventilation. Pigmentation, which is a characteristic feature in peripheral airways, was reported to represent submucosal deposition of inhaled substances². Peripheral airways exhibited an accordion pattern of smooth muscles which was similar in central airways, despite of no cartilage rings. Change in this structure of the mucosal surface associated with dilatation was classified as ectasis in peripheral airway lesions². Slavin and Nunn³ described that the degree of bronchiolectasis was correlated well with the period and/or magnitude of artificial ventilation and PEEP level from the study at autopsy. No clinical study has been conducted to clarify the morphological changes in peripheral airways. Ectasis and pallor became prominent during long mechanical ventilation in this study, even if patient's oxygenation and the chest X-ray findings improved. Ectasis in this study is mostly likely barotrauma in peripheral airways by mechanical ventilation. Pallor of bronchi wall suggests ischemia of mucosa, which may be caused by disturbance of microcirculation from the pulmonary or the bronchial circulation. Clarification of these relationship must need further studies.

Morphological changes in peripheral airways of two patients who were on mechanical ventilation due to acute respiratory failure were studied by using the fiberoptic bronchoscope of 1.8 mm outer diameter. Dilatation and pallor of the peripheral bronchial wall were important main findings which became more prominent in relation

with the period of mechanical ventilation. These changes, however, were not related with the chest X-ray findings or the arterial oxygenation. This study suggests that the clinical findings during mechanical ventilation do not reflect the pathological changes in peripheral airways. It gives us some warnings when positive pressure ventilation is applied for the patients.

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References

1. Tanaka M, Satoh M, Kawanami O, et al: A new bronchofiberscope for the study of discases of very peripheral airways. *Chest* 85:590-594, 1984
2. Tanaka M, Kawanami O, Satoh M, et al: Endoscopic observation of peripheral airway lesions. *Chest* 93:228-233, 1988
3. Slavin G, Nunn JF, Crow J, et al: Bronchiolectasis - a complication of artificial ventilation. *Br Med J* 285:931-934, 1982