

Ventilator weaning using a fenestrated tracheostomy tube with a speaking valve

Masatoshi Fukumoto, Haruko Ota and Hajime Arima

Tracheostomy is performed in patients who need long-term translaryngeal intubation. In patients requiring ventilator support, tracheostomy often also accelerates weaning from mechanical ventilation. However, some patients cannot be weaned despite minimal need for respiratory support. We report two patients with tracheostomies who had difficulty in weaning, but were finally freed from mechanical ventilation through use of a fenestrated tracheostomy tube with a speaking valve.

Clinical records

Patient 1

An 81-year-old man underwent mechanical ventilation because of respiratory failure associated with pulmonary bleeding. As weaning was difficult, tracheostomy was performed on Day 29 in the ICU. Weaning was accelerated, but he continued to need slight ventilator support (pressure support, 2 cmH₂O; positive end-expiratory pressure, 5 cmH₂O). When ventilator support was discontinued, respiratory rate increased, and arterial oxygenation deteriorated. As we considered that effective vocal cords might resolve the impasse, a fenestrated tracheostomy tube with a speaking valve (KOKEN Co Ltd, Tokyo, Japan) was substituted for a standard tracheostomy tube on ICU Day 40. We used a non-cuffed tube, allowing inspiratory flow to pass through both the tube and the patient's vocal cords, while expiratory flow passed only through the vocal cords. Immediately after the tube exchange, there was an increase in the duration of chest wall expansion in the respiratory cycle (Figure 1), and no deterioration in arterial oxygenation when ventilator support was withdrawn and replaced by supplemental oxygen therapy via mask. Vocal cord movement was confirmed by fiberoptic inspection. Chest x-ray 5 days after the tube exchange showed a decrease in atelectasis.

Patient 2

An 86-year-old man underwent mechanical ventilation for aspiration pneumonia. As weaning was difficult, tracheostomy was performed on ICU Day 21. Although the patient needed only slight ventilator support, he developed wheezing, and arterial oxygenation deteriorated when this support was discontinued. Fiberoptic bronchoscopy under spontaneous respiration showed tracheomalacia during

ABSTRACT

We describe two patients with tracheostomies who showed difficulty in weaning from mechanical ventilation, but were eventually weaned after use of a fenestrated tracheostomy tube with a speaking valve. The first patient underwent mechanical ventilation after pulmonary bleeding, while the second needed ventilator support because of tracheomalacia. Both patients needed only slight ventilator support but developed respiratory distress when it was discontinued. When the standard tracheostomy tube was replaced by a fenestrated tracheostomy tube with a speaking valve, each patient was easily weaned from mechanical ventilation. With a valved tube, vocal cords can exert part of their original function during expiration. The valved tube allowed the first patient to control breath-holding, and the second to avoid tracheal collapse. Regaining vocal cord function improved their pulmonary mechanics, which was demonstrated by dramatic improvement of findings on chest x-ray and computed tomography. A fenestrated tracheostomy tube is usually used to improve daily activities of patients with tracheostomies, but might be worth trying for difficult ventilator weaning.

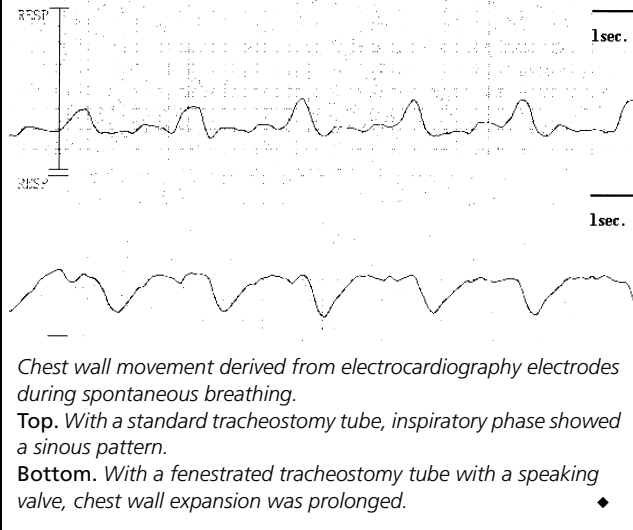
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expiration. Considering his age, conservative therapy was chosen, even though this might take longer than surgical therapy to achieve complete weaning from ventilator support. On ICU Day 51, the valved tracheostomy tube (same as that used in Patient 1) was tried. Arterial oxygenation did not deteriorate when ventilator support was withdrawn and replaced by supplemental oxygen via mask. He did not become wheezy. Chest computed tomography 18 days after the tube exchange showed a remarkable decrease in atelectasis (Figure 2).

Discussion

The decision to perform tracheostomy is based on consideration of its advantages versus disadvantages. Advantages include more effective airway suctioning and improved patient comfort,¹ which sometimes accelerate weaning from mechanical ventilation. However, mortality rate of tracheostomised patients is much higher when they are

Figure 1. Chest wall movement in Patient 1 before and after tracheostomy tube exchange



dependent on a ventilator.² Therefore, whether the patient can be freed from mechanical ventilation is a key factor influencing prognosis.

Vocal cords determine airflow, pattern of breathing and airway resistance.³ When vocal cords are bypassed with a tracheal tube or a standard tracheostomy tube, these functions are disturbed. During normal respiration, vocal cords begin to move toward the midline at the end of inspiration, and the glottis aperture remains narrowed until about 95% of the expiratory time has elapsed.³ Vocal cord

movement contributes to maintaining pulmonary function; reduced functional residual capacity has been seen after tracheostomy,⁴ as well as reduced arterial oxygenation.⁵

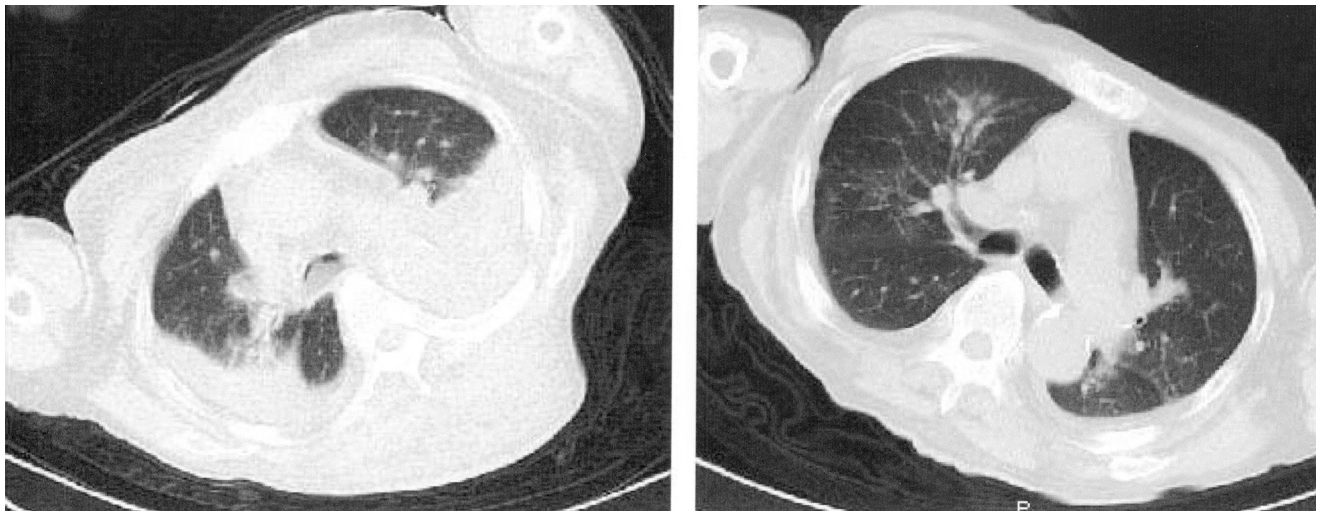
In Patient 1, the respiratory pattern showed remarkable change after the tube exchange, attributable to the patient regaining vocal cord function. With functioning vocal cords, he could control breath-holding and expiratory resistance. In Patient 2, the respiratory pattern showed less change after the tube exchange, but he did not develop wheezing. We speculate that native expiratory resistance provided by the vocal cords prevented tracheal collapse during expiration, and that vocal cord function helped to maintain greater functional residual capacity.

In summary, we describe two tracheostomised patients with difficulty in weaning who could be freed from mechanical ventilation after a standard tracheostomy tube was replaced by a fenestrated tracheostomy tube with a speaking valve. Utilising the vocal cords in respiration contributes to improving pulmonary mechanics in tracheostomised patients. A fenestrated tracheostomy tube is usually used to improve daily activities of tracheostomised patients, but we consider it worth trying for patients showing difficulty in weaning from mechanical ventilation.

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Figure 2. Computed tomography of the chest in Patient 2 before and after tracheostomy tube exchange



Computed tomography of the chest showed a major decrease in atelectasis when the standard tracheostomy tube was replaced by a fenestrated tracheostomy tube with a speaking valve. **Left.** With standard tracheostomy tube. **Right.** 18 days after replacement by a fenestrated tracheostomy tube. ♦

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