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Breathing Exercise in High Cervical Cord Injury : Report of two Cases

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Abstract Spinal cord injury patients, particularly high cervical cord injury patients, have breathing disturbance due to diaphragm paresis. They are maintained on a ventilator, which has a tremendous restriction on the activities of daily living (ADL). We used breathing care to wean two patients from the ventilator. They were both males, one aged 26 years and the other 17. Both patients had complete quadriplegic paralysis and diaphragm paresis due to C₃ dislocation. The breathing care consisted of exercises for phlegm drainage, muscle strengthening, and prevention of muscle shortening and joint stiffness. In one patient, weaning from artificial ventilation was successful, spontaneous breathing was achieved, and it was possible to remove the tracheal canula by Day 492. The other patient improved to take off the ventilator for 5 hours at a time except during meal and sleep by Day 99. For both patients there were significant effects not only on the ADL and mentality, but also on nursing care given to them.

Key words : High cervical cord injury, Breathing disturbance, Breathing exercise, Weaning, Physical therapy

Introduction

Spinal cord injury patients have breathing disturbance as well as motor and sensory disturbances. The breathing disturbance is caused by diaphragm paresis, especially in high cervical cord injury patients. Such disturbance greatly affects the patient's activities of daily living (ADL) since artificial ventilation is frequently required.

The desired outcome of breathing care is to set a patient free from a ventilator. For breathing care, it is very important to provide for natural conditions as much as possible ; i.e. avoidance of unnatural restriction to maintain patient's life. Here, we present our

method of breathing care for two high cervical cord injury patients with informed consent, which consists of breathing exercises for weaning patients from the ventilator.

Case reports

There is a need for fixation of patient's shoulder and head to maintain the cervical fracture fixed, and for phlegm drainage before breathing exercise. Figure 1 shows the process for fixation of a patient's shoulder and head, and assistance in phlegm drainage and breathing. We use clapping, vibration, and pressure on the patient's thorax to clear the lungs (Fig. 2).



Fig. 1 Fixation of a patient's shoulder and head, and assistance to him for phlegm drainage and breathing. (with permission)



Fig. 2 Use of clapping, vibration, and pressure on a patient's thorax for phlegm drainage. (with permission)

During ventilator use, bronchioli are shrunken in size in comparison to their size in normal breathing. Expiration is not adequate, and the residual air volume increases. To prevent this, we assist the patient with expiration by pressing on his lower thorax, synchronizing the respiratory cycle as shown in Fig. 3.

The following two patients with high cervical cord injury were helped in breathing exercises in our hospital. After an explanation of the purpose and method of breathing exercises, they agreed to participate.



Fig. 3 Pressing on a patient's lower thorax for expiration. (with permission)

Patient 1 :

Age : 26 years. Sex : Male. Height : 174 cm. Weight : 65 kg. Injury : July 1989. Diagnosis : C_{3,4} dislocation, quadriplegia and diaphragm paresis.

Clinical course to weaning

Day 1 (1st day in our hospital, 1st day from the injury) : The patient was on a ventilator. Day 2 : Breathing exercise was started. Vital capacity (VC) was 0.62 ml/kg.

Day 15 : Weaning from artificial ventilation was begun (VC=1.46 ml/kg). The patient felt much better than the time when breathing exercise was started. The process is shown in Fig. 1, 2 and 3.

Day 19 : Spontaneous breathing for 45 seconds was possible with breathing assistant muscles (VC=1.54 ml/kg).

Day 57 : Removal of neck collar from Crutchfield traction (VC=2.77 ml/kg, spontaneous breathing for 97 seconds).

Day 71 : Recognition of contraction of the left part of the diaphragm (VC=3.38 ml/kg, spontaneous breathing for 50 minutes).

Day 80 : The contraction of the diaphragm was lost and the patient had hypoxic episode during breathing exercise due to inability to breath spontaneously.

Day 88 : Recognition of re-contraction of the left part of the diaphragm (VC=3.08 ml/kg, spontaneous breathing for 5 minutes).

Day 143 : Removal of the ventilator except during meal and sleep (VC = 10.77 ml/kg).

Day 211 : Beginning of weaning while sleeping (VC=15.38 ml/kg).

Day 476 : Spontaneous breathing while sleeping (VC=21.54 ml/kg).

Day 492 : Removal of the tracheal canula after the finishing of the weaning (VC=21.54 ml/kg).

Patient 2 :

Age : 17 years. Sex : Male. Height : 184 cm. Weight : 62 kg. Injury : March 1994. Diagnosis : C₃ dislocation and complete spinal cord injury, quadriplegia and diaphragm paresis.

Clinical course to weaning

The period from the 1st day to 162nd day from the injury : The patient had phlegm drainage exercise in another hospital but did not have breathing exercise to attempt weaning from a ventilator.

Day 1 (the 1st day in our hospital, 163rd day from the injury) : The patient was on a ventilator but was able to breathe spontaneously without the ventilator for about 20 seconds with the help of the platysma muscle (VC=4.84 ml/kg).

Day 2 : Beginning of weaning. Breathing was possible for 60 seconds without the ventilator (VC=4.84 ml/kg).

Day 28 : Spontaneous breathing for 45 minutes (failed to continue by fatigue of the breathing assistant muscles), SpO₂ was stable at 92%~93% (VC=5.65 ml/kg).

Day 92 : Movement using by an electric wheel chair for about 90 minutes during spontaneous breathing (VC=6.13 ml/kg).

Day 99 : The patient was able to breathe without the ventilator for about 4.5~5.0 hours at a time except during meal and sleep. Contraction of the diaphragm was not recognized, but the patient could use the breathing assistant muscles very well (VC=6.77 ml/kg).

Discussion

High cervical cord injury patients not only have motor, sensory and autonomic nerve dysfunction, but also have breathing dysfunction. It goes without saying that breathing is an indispensable part to supply oxygen to the body tissues, bringing oxygen into the alveoli, into capillaries by diffusion and then

into normal circulation. For high cervical cord injury patients, oxygen supply and diffusion from the alveoli are maintained and improved through breathing exercise. Proper breathing exercise is aimed to increase the strength of the breathing assistant muscles such as sternocleidomastoideus and scalenus muscles and to maintain high VC, thoraco-pulmonary compliance, and to drain phlegm. Phlegm drainage is indispensable for maintaining normal ventilation. Postural drainage allows the phlegm to flow into the trachea or bronchus easily under the pull of gravity. The sitting or head-down position is usually necessary for adequate removal of phlegm from the different parts of the lung¹⁾. However, it is difficult to maintain these positions during periods of neck fixation and bed rest.

According to recent standards of weaning^{2,3)}, patients with chronic obstructive pulmonary disease must have VC over 10~15 ml/kg and enough cough strength to drain phlegm. In this study, the patients felt better even with VC at 1.46 ml/kg (patient 1) and VC at 4.84 ml/kg (patient 2) than the time after the injury. Therefore, the cited VC standard may not be appropriate for patients with diaphragm paresis. Breathing disturbance in patients with diaphragm paresis is caused by muscle paresis of neurological origin, which is not caused by lung itself.

The first patient improved to breathe without a ventilator except during meal and sleep (VC=10.77 ml/kg) by Day 143 and of being able to breathe spontaneously while sleeping (VC=21.54 ml/kg) by Day 476 from the injury. Finally, the tracheal canula was removed after the finishing of the weaning (VC=21.54 ml/kg) on Day 492. The second patient breathed spontaneously without a ventilator for about 5 hours at a time except during meal and sleep by Day 99. We assume that weaning of our cases was started much earlier than those in other reports^{2,3)}. Clapping, vibration and pressure on the patient's thorax to remove of phlegm must be effective for earlier weaning. The 2 patients felt good after breathing exercise, though their VCs were very low.

We must help patients to exercise even under risky conditions in order to free them

from the ventilator as early as possible. So that SpO₂ and ECG should be monitored during breathing exercise to avoid serious complications.

Weaning from ventilators in high cervical cord injury patients with diaphragm paresis influences not only on their ADL and mentality, but also on the nursing care to them. If a patient's breathing function does not meet the required criterion for the total weaning, flexible weaning, at least for short periods of time through breathing exercise, should be achieved. Available standards for weaning from a ventilator may not be adequate for patients with spinal cord injury. A weaning standard for spinal cord injury patients should be established in the near future.

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References

- 1) Miyagawa, T. and Ishikawa, A. : The View of Respiratory Physical Therapy (in Japanese). *J Physical Therapy*, **21** : 678-685, 1993.
- 2) Toyooka, H. and Nagase, M. : *How to use the Ventilator* (in Japanese). Syourinsya, Tokyo, 1987, p.158.
- 3) Tanimoto, S. and Suwa, K. : *Respiratory Care in Ward* (in Japanese). Kounando, Tokyo, 1990, pp.7-12 and pp.50-58.