≪Case Report≫

A case report of High-Flow Nasal Cannula Oxygenation therapy for acute respiratory failure in patients with ventricular septum defect combined with right-left shunt

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Abstract :
We reported a case of a 51-year-old woman with acute respiratory failure for whom ventricular septum defect combined with right-left shunt was successfully performed with the use of high-flow nasal cannula oxygenation (HFNCO) therapy. She had suffered from ventricular septum defect (VSD) and pulmonary artery banding was performed at four-year old. However, residual VSD had not been pointed out. Until today, she had been able to work and do housework. When she suffered from pneumonia and admitted to the hospital, she also pointed out chronic cardiac failure combined with pulmonary hypertension (pulmonary arterial pressure 115/45(76) mmHg, pulmonary vascular resistance 874 dyne/sec/cm^{5}). Thereafter, home oxygen therapy (HOT) was started (2 L/min O_2). This time, she suffered from pneumonia and hypoxemia under HOT (SpO_2 84 %). She complained of dyspnea even at rest and had labored breathing through pursed lips after a short conversation, defined as class IV in the Hugh-Jones classification. She was transferred to our intensive care unit (ICU) and underwent HFNCO (Flow rate 60 L/min, FiO_2 0.6). After starting HFNCO, respiratory rate was decreased from 35 to 25 times/min and dyspnea was improved immediately. Day 5, she transferred to regular ward. Day 7, HFNCO was stopped and conventional oxygen therapy was started. The patient was transferred back to the local hospital for rehabilitation on Day 15.

Keywords : High-Flow Nasal Cannula Oxygenation, ARDS, VSD.

Introduction

We reported the case of a patient with acute respiratory failure for whom ventricular septum defect combined with right-left shunt was successfully performed with the use of high-flow nasal cannula oxygenation (HFNCO) therapy and avoided tracheal intubation.

Case Presentation (Figure)

51 year-old female. 161 cm in height, 41.3 kg in weight. Immediately after birth, cardiac murmur was pointed out. She had suffered from ventricular septum defect (VSD) and pulmonary artery banding was performed at four-year old. After surgery, her growth and development were normal. Until today, despite of feeling shortness

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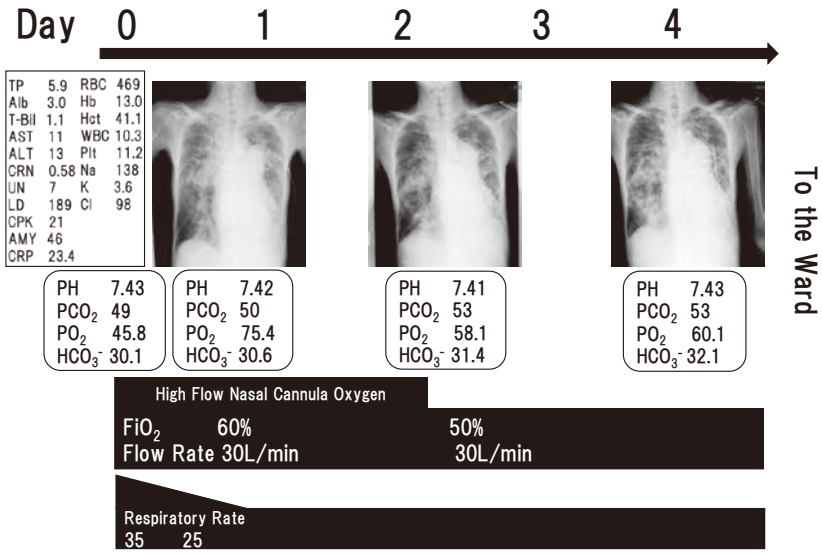

Figure Clinical Course after Admission

in breathing and palpitation in the everyday life, she had been able to work and do housework. She suffered from pneumonia and admitted to the hospital at forty-eight years old. She also pointed out chronic cardiac failure due to residual VSD combined with pulmonary hypertension (pulmonary arterial pressure 115/45(76) mmHg, pulmonary vascular resistance 874 dyne/sec/cm^5) and thereafter home oxygen therapy (HOT) was started (2 L/min of oxygen). Right-left shunt blood flow through residual VSD was also pointed out. Medication (sildenafil citrate 60mg, Ambrisentan 5mg) was started. After medication, pulmonary hypertension was not improved (PA 105/49(68) mmHg, PVR 539 dyne/sec/cm^5). Continuous infusion of prostacyclin (27.9 ng/kg/min) was also started. After prostacyclin infusion, pulmonary hypertension was improved (PA 80/34(55) mmHg, PVR 417 dyne/sec/cm^5). Oxygenation was kept at SpO_2 90% under 4L/min of oxygen with nasal oxygen cannula. Cardiothoracic rate (CTR) was gradually increased to 65 % without apparent dyspnea. Afterward, she registered the lung transplantation recipient. VSD closure was planned at the lung transplantation surgery. This time, she suffered from pneumonia and hypoxemia under HOT (SpO_2 90%). She complained of dyspnea even at rest and had labored breathing through pursed lips after a short conversation, defined as class IV in the Hugh-Jones classification. She was transferred to our intensive care unit (ICU). At admission to the ICU, heart rate (HR) was 130 beats/min, non-invasive blood pressure (NIBP) was 110/60 mmHg, respiratory rate (RR) was 35 times/min, SpO_2 was 84 % under 10 L/min of oxygen with oxygen mask. Consciousness was clear. To prevent increasing right-left shunt blood flow through residual VSD, positive pressure ventilation via tracheal intubation was not plan to done. However, she refused non-invasive positive pressure ventilation (NIPPV) by discomfort of a tight mask and a forced air flow. Therefore, HFNCO (Flow rate 60 L/min, FiO_2 0.6) was started. Immediately after starting HFNCO, RR was decreased to from 35 to 25 times/min. Dyspnea and Oxygenation was improved (Before: PH 7.427, PO_2 45.8 mmHg, PCO_2 49 mmHg; After: PH 7.424, PO_2 75.4 mmHg, PCO_2 49.7 mmHg). Haemophilus influenza was detected in sputum culture. As antimicrobial treatment, meropenem 1.5 g/day and minocycline 200 mg/day were done. Afterward, respiratory failure was gradually improved and discharged from ICU to the ward on Day 5. HFNCO was kept for 7days after admission and changed to 2 L/min of oxygen by nasal cannula. Day 15, she discharged to other hospital for respiratory rehabilitation.

Discussion

This is a success case for treating cardiac failure using HFNCO, because of refusing NPPV therapy by patient. In this case, positive pressure ventilation via tracheal intubation might induce a right cardiac failure by increasing pulmonary artery pressure, because of a right-left shunt combined with residual VSD. Therefore, another oxygen therapy was

needed. In recent years, NPPV has been done in routine clinical therapy for patients suffering from left cardiac failure.[1] However, asynchronies for the spontaneous breathing is a serious problem leading for discontinuing NPPV therapy.[2] Asynchronies for spontaneous breathing might magnitude the changes of intrathoracic pressure and induce an increasing pulmonary artery pressure. Therefore, asynchronies for spontaneous breathing must be prevented to treat a cardiac failure, especially in a cardiac shunt disease. From asynchronies points of view, HFNCO might be suitable for patients with cardiac shunt diseases, because HFNCO is not a forced positive pressure ventilation device. However, there has not been an obvious evidence for improving cardiac failure.[2]

HFNCO has been reported to provide four superior effects for improving oxygenation compared with traditional oxygen therapy via face-mask.[3-8] First is to maintain stable inspiratory oxygen concentration. Second is to increase tidal volume by PEEP effect induced by high flow gases. Third is to decreasing end-tidal CO_2 by decreasing rebreathing and washout effect. Fourth is to increasing residual lung capacity induced by increasing intrathoracic pressure. HFNCO provided another effect to decreasing dyspnea by humidifying and warming nasal mucosa using humidified and warmed inspired gases.[9, 10] In addition, HFNCO could prevent excessive airway pressure because it consisted of the open respiratory circuit and non-sedated patients could avoided it consciously. These effects were contributed for improving respiratory muscle fatigue in patients with acute respiratory failure leading to decrease systemic oxygen consumption.

However, HFNCO system could not provide a respiratory monitoring system such as airway pressure, air flow and respiratory rate. A prospective observational study to study impact of HFNCO therapy on intensive care unit patients reported HFNCO could decrease respiratory rate more certainly than conventional oxygen therapy via face-mask.[11] Another report in patients underwent critical care also indicated the effects of decreasing respiratory rate.[12] Respiratory rate must be one of important index for evaluating the effect of HFNCO. In this care, after starting HFNCO, oxygenation could not be increased but the feeling of discomfort and respiratory rate were improved rapidly. Therefore, respiratory effort might be decreased judged from this effects. Further study should be done to reveal the indicator of HFNCO effects under clinical setting.

Conclusion

Under careful respiratory rate monitoring, HFNCO might be a useful device for patients with acute respiratory failure combined with a residual right-left shunt cardiac disease who is difficult to do positive pressure ventilation.

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