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0232. Evaluation of HFNC'S wash out effect; a comparison of open- and closed-mouth models

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Introduction

Although clinical studies of the high-flow nasal cannula (HFNC) and its effect on positive end-expiratory pressure (PEEP) have been performed, the mechanism of the washout effect and its relation with HFNC flow have not been well evaluated. Therefore, we made a respiratory model that can exhale with controllable end-tidal PCO_2 ($P_{ET}CO_2$) to evaluate the washout effect of HFNC.Objective. To evaluate the quantitative results of HFNC's washout effect comparing open- and closed-mouth models.

Methods

Optiflow™ (Fisher and Paykel Healthcare, Auckland, NZ) was used as the HFNC system. The artificial respiratory model consisted of a lung model (the Dual Adult Training and Test Lung, Michigan Instruments Inc., Grand Rapids, MI, USA) and a ventilator (Puritan Bennett™ 840, Covidien, Dublin, Ireland). The HFNC and the respiratory model were connected by the airway model (Endotracheal Intubation Training Model LM-059, Koken Co., Ltd., Tokyo, Japan). Respiratory settings were as follows: respiratory rate, 16 breaths/min; inspiratory time, 1 second; and tidal volume (V_T), 300, 500, or 800 mL. CO_2 was infused into a distal site of the lung model to maintain $P_{ET}CO_2$, measured just below the glottis, at 40 mmHg at each V_T setting without HFNC. HFNC flow was changed from 10-60 L/min in each V_T setting, and the change of $P_{ET}CO_2$ was measured in the open- and closed-mouth models.

Results

With any V_T setting in the open-mouth model, $P_{ET}CO_2$ quickly decreased to 20-25 mmHg as HFNC started at 10 L/min. Thereafter, $P_{ET}CO_2$ did not change with an increasing HFNC flow (Figure: solid lines). With the closed-mouth model, $P_{ET}CO2$ gradually decreased as the HFNC flow was increased. The V_T settings of 300 and 500 mL had the same trends and reached the bottom level of 22 mmHg with HFNC flow over 50 L/min. The V_T setting of 800 mL had a smaller decrease in $P_{ET}CO_2$ to 28 mmHg (Figure 1: dotted lines).

Discussion

Generation of PEEP by HFNC needs high flow as 35 L/min to generate PEEP of 3 cmH_2O[1)]. In this study, it was demonstrated that HFNC's washout of the dead space is effective with relatively low flow as low as 10 L/min in open-mouth model. HFNC flow of 10 L/min can deliver gas of 166 mL/min, and this amount of gas delivery was thought to be enough to wash out the dead space during the exhalation time. The effect was weaker in the closed-mouth model, but by increasing the HFNC flow produced an adequate effect. In this closed-mouth model, more gas leaked from the nostril instead of the mouth, and therefore,

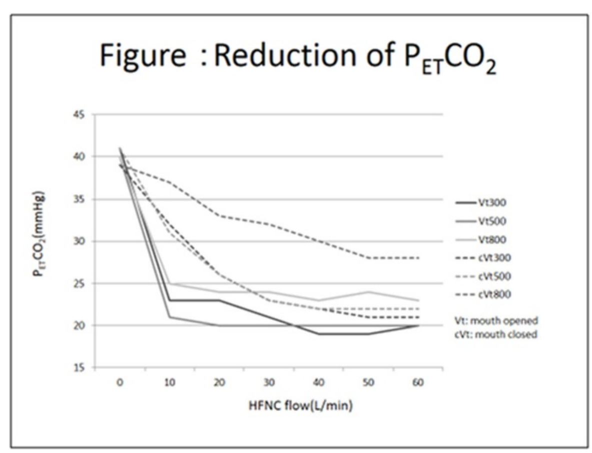

Figure 1 Reduction of $P_{ET}CO_2$

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less gas washed out the dead space, which caused a need for more HFNC flow to lower the $P_{ET}CO_2$.

Conclusions

We concluded that the washout effect depends on HFNC flow especially with closed-mouth breathing while it may reach maximum with a relatively low flow of 10 L/min with open-mouth breathing.

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Reference

1. Parke R: **Nasal high-flow therapy delivers low level positive airway pressure.** *Br J Anaesth* 2009, **103**:886-890.

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