

Physiologic Effects of High Flow Nasal Cannula Compared to Conventional Oxygen Therapy Postextubation: A Randomized Crossover Study

R. Basoalto¹, L. Damiani², Y. Jalil², P. Garcia², D. Carpio¹, M. Bachmann¹, L. Alegría¹, V. Oviedo¹, G. Buggedo¹, J. Retamal¹, A. Bruhn¹

1 Departamento de Medicina Intensiva, Pontificia Universidad Católica de Chile, Santiago, Chile

2 Departamento de Ciencias de la Salud, carrera de Kinesiología, Pontificia Universidad Católica de Chile, Santiago, Chile.

Corresponding author's email: alejandrob Bruhn@gmail.com

Rationale:

Several studies have shown the clinical impact of high flow nasal cannula (HFNC) in preventing weaning failure. However, no study has performed a comprehensive evaluation of the physiological effects of HFNC in the post-extubation period.

Objective:

To determine the physiological effects of HFNC compared to conventional oxygen therapy in the post-extubation period.

Methods:

Prospective randomized crossover study in the postextubation period of patients with acute respiratory failure (ARF), which was approved by the Institutional Scientific Ethics Committee of Pontificia Universidad Católica de Chile. Critically ill patients connected to mechanical ventilation (MV) more than 48 hours, with PaO₂/FiO₂ <300 mmHg, and in whom the physician planned to perform a spontaneous breathing test, were included. After obtaining informed consent a catheter with an esophageal and gastric balloons, and electrodes to record the electrical activity of the diaphragm (EAdi) was installed. In addition, an electrical impedance tomography (EIT) belt was placed around the chest. After extubation, patients were connected to HFNC set at 50 L/min for one hour and conventional oxygen therapy (venturi mask) for other hour in a random sequence. Esophageal and gastric pressures, as well as EAdi and EIT measurements were performed at baseline and after each hour.

Results:

Twenty one patients (13 men) aged 60 ± 16 years were included. Patients had been on MV for 8.7 ± 3.8 days. Compared with conventional oxygen therapy, HFNC significantly decreased respiratory rate (RR) and the respiratory effort as assessed by a decrease in esophageal pressure swings (ΔP_{es}) and pressure-time product minute (PTPmin) of 19% and 40%, respectively. HFNC also increased end-expiratory lung volume and PaO₂/FiO₂. However, no differences were observed in $\Delta EAdi$ or in neuro-ventilatory efficiency.

Conclusion:

The use of HFNC in the post-extubation period in patients with acute respiratory failure decreases work of breathing, and increases end-expiratory lung volume, dynamic compliance, and gas exchange.

Variable	Conventional Oxygen therapy	HFNC	P Value
Δ Pes, cmH ₂ O	7.0 [5.6 – 10.4]	5.7 [4.2 – 7.1]	0.0007
PTPes, cmH ₂ O . s	6.5 [5.2 – 9.1]	4.4 ± [3.4 – 6.8]	0.0006
PTP _{min} , cmH ₂ O . s/min	148 [107 - 193]	88 [67 - 154]	<0.0001
Pdi, cmH ₂ O	7.3 [6.15 – 11.2]	5.9 [4.96 – 7.73]	0.0067
RR, bpm	24 ± 6	22 ± 5	0.0017
Tidal Volume, ml	358 ± 113	330 ± 100	0.3263
Minute Volume, L/min	8 ± 3.3	6.9 ± 2.8	0.0572
Ventilatory Ratio	1.19 ± 0.23	1.09 ± 0.41	0.4015
Δ EELV _{glob} (change from conventional oxygen), ml	-	244 [121 - 662]	<0.0001
Dynamic compliance, V _T / Δ Pes (ml/cmH ₂ O)	53 ± 28	61 ± 24	0.078
Δ EAdi, μ V	13.4 [9.5 – 16.1]	9.7 [7.6 – 10.1]	0.332
Neuro-ventilatory efficiency, V _T /EAdi (ml/ μ V)	30 ± 19.4	43.4 ± 50.7	0.262
Neuromechanical efficiency, cmH ₂ O/ μ V	0.65 [0.43 – 0.71]	0.61 [0.56 -0.76]	0.5966
PaO ₂ /FiO ₂ , mmHg	252 ± 73	276 ± 78	0.0252
PaCO ₂ , mmHg	37 ± 4.65	37 ± 4.01	0.8336
SvO ₂ , %	77 ± 6.6	75 ± 7.3	0.3901
pH	7.44 ± 0.04	7.45 ± 0.04	0.8546
MAP, mmHg	98 ± 15	95 ± 13	0.2382
HR, bpm	84 ± 12	85 ± 11	0.1861

Table 1. Δ Pes: Esophageal pressure swing, PTP: pressure time product; PTPmin: pressure time product per minute; RR: Respiratory rate; Pdi: Transdiaphragmatic pressure; VT: Tidal volume; Δ EELV: Global change of end-expiratory lung volume (change from oxygen mask); Δ EAdi: Electrical activity of the diaphragm; SVO₂: Central venous saturation; MAP: Mean arterial pressure; HR: Heart rate.

References:

- Mauri T, et al. Physiologic Effects of High-Flow Nasal Cannula in Acute Hypoxemic Respiratory Failure. Am J Respir Crit Care Med. 2017 May 1;195(9):1207-1215.
- Hernández G. et al. Effect of Postextubation High-Flow Nasal Cannula vs Conventional Oxygen Therapy on Reintubation in Low-Risk Patients: A Randomized Clinical Trial. JAMA. 2016 Apr 5;315(13):1354-61

Funding:

Grant FONDECYT N ° 1191709 and CONICYT-PFCHA/Doctorado Nacional 2020-folio 2120175