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Small Lumen Ventilation through a Cuffed Jet Ventilation Catheter: Efficiency and Safety

Dietmar Enk *, Sebastian Enk
** Department of Anesthesiology, Maastricht University Medical Center, Maastricht, The Netherlands*

Introduction

As expiratory ventilation assistance (EVA) is most efficient in case of complete upper airway obstruction [1], it makes sense to occlude the upper airway for providing small lumen ventilation during elective surgery. In this case continuous airway pressure monitoring is mandatory. Goal of this *in-vitro* study was to evaluate Ventrain, a flow-regulated, manually operated ventilator capable to assist expiration by jet-flow generated suction (Dolphys Medical, Eindhoven, The Netherlands; www.ventrain.com, see QR code) [2], in combination with the prototype of a cuffed jet ventilation catheter (CJVC) having a separate pressure monitoring channel [3].

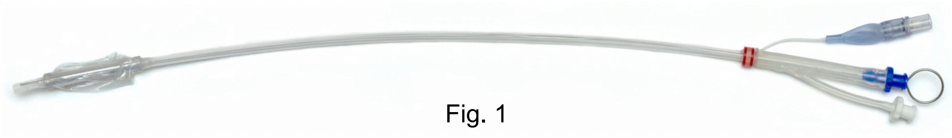

Fig. 1

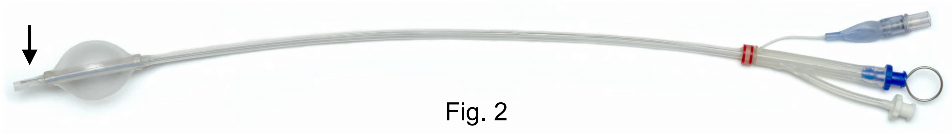

Fig. 2

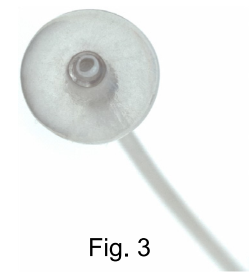

Fig. 3

Fig. 1: Prototype of the 40 cm long cuffed jet ventilation catheter; cuff deflated; the blue female Luer connects to the ventilation lumen (metal stylet inside), the white Luer to the pressure monitoring channel.
Fig. 2: Cuff inflated via the blue pilot balloon; the arrow indicates the side opening of the pressure monitoring channel distally of the cuff.
Fig. 3: The inflated cuff ensures axial alignment of the opening of the 2.5 mm inner diameter ventilation lumen.

Material and Methods

Ventrain was connected to a pressure compensated flowmeter at an oxygen flow of 15 L/min and to the 2.5 mm inner diameter ventilation lumen of the 40 cm long CJVC. In an LS 800 lung simulator (Dräger Medical AG, Lübeck, Germany) sealed by the insufflated cuff of the CJVC, time for inspiration and passive expiration (Ventrain disconnected) as well as assisted expiration (EVA) of 500 mL of oxygen was measured at different compliances and resistances (see table). Pressure readings on a standard cuff pressure manometer attached to the pressure monitoring channel of the CJVC (with 100 cm long tubing in between) and on the simulator's lung manometer were photo documented. Achievable minute volumes (MV) and inspiration/expiration-ratios (I/E-ratio) were calculated and the maximum difference between tracheal and lung pressures (Δp) determined.

Results

Because of small standard deviations only the means of five repeated measurements are presented.

compliance (mL/mbar) **resistance (mbar/L/s)**	**100** **2**	**100** **32**	**50** **2**	**50** **32**	**30** **2**	**30** **32**
inspiratory time (s)	2.02	2.07	2.17	2.16	2.23	2.26
expiratory time (s) passive	8.68	8.91	6.26	6.35	4.86	5.02
expiratory time (s) EVA	1.93	2.07	2.02	2.07	2.02	2.10
MV (L/min) passive	2.80	2.73	3.56	3.52	4.23	4.12
I/E-ratio (s) passive	1/4.30	1/4.31	1/2.89	1/2.94	1/2.18	1/2.22
MV (L/min) EVA	7.59	7.25	7.16	7.09	7.07	6.89
I/E-ratio (s) EVA	1/0.96	1/1.00	1/0.93	1/0.96	1/0.91	1/0.93
inspiratory Δp (mbar)	3	8	3	8	2	8
expiratory Δp (mbar) passive	0	1	1	1	1	3
expiratory Δp (mbar) EVA	3	8	4	9	3	9

Conclusion

The combination of the CJVC-prototype with Ventrain allows adequate minute volume ventilation in adult patients. The pressure measured in the simulator's trachea reflects lung pressure with the precision of a few millibars with lung resistance being a determining factor.

References

1) Hamaekers A et al.: Eur J Anaesthesiol 2010, 27 (suppl. 47): 19AP1-9
2) Hamaekers A, Borg P, Enk D: Br J Anaesth 2012, 108: 1017-21
3) Enk D: Patent application (10 2009 013 205.8), German Patent Office, 17.3.2009

Conflict of Interests

Dietmar Enk is the inventor of the Ventrain and receives royalty payments from Dolphys Medical.

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Corresponding author: d.enk@mumc.nl